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UNIVERSITY OF MICHIGAN.

Department of Engineering.

ANNOUNCEMENT

FOR THE YEAR

1895-96.

Courses Offered in 1895-96.

The courses of study for 1895-96 will be substantially as described in the following paragraphs. In this list will be found all the prescribed work for the students in civil, mechanical and electrical engineering. For the elective courses, and for introductory and explanatory notes, see ANNOUNCEMENT OF DEPARTMENT OF LITERATURE, SCIENCE, AND THE ARTS. For the requirements for graduation, see the CALENDAR for 1894-95, pp. 111 to 113.

The prescribed work in French and German has been reduced to *fifteen* hours, for students who enter under the requirements for 1895. In that case for advanced work in these languages consult the ANNOUNCEMENT OF DEPARTMENT OF LITERATURE, SCIENCE AND THE ARTS.

The course in astronomy has been lengthened to *three* hours. Former Course 1, civil engineering, is now Course 5*b*, mechanical engineering; and Course 2, civil engineering, has been changed to Course 7*b*, mechanical engineering.

FRENCH.

Students of engineering are not admitted to the other courses offered in French, except by special permission.

FIRST SEMESTER.

B. Narrative Prose. Sec. I, *M*, *W*, at 8. Room 2, U. H. Mr. ELDEN. Sec. II, *Tu*, *Th*, at 3. Room 12, U. H. Mr. BRANDON.

Course B is open to those who have taken Course A, or who have passed an entrance examination in French.

D. Scientific Reading. *Tu*, *Th*. Sec. I, at 1. Room 12, U. H. Mr. BRANDON. Sec. II, at 3. Room 2, U. H. Mr. FRANCOIS.

SECOND SEMESTER.

A. Beginner's Course. Grammar and Reader. *M, W, Th, F.* Sec. I, at 11. Room 12, U. H. Mr. FRANCOIS. Sec. II, at 3. Room J, U. H. Mr. BRANDON.

C. Descriptive Prose. *Tu, S,* at 8. Room 9, U. H. Mr. ELDEN.

GERMAN.

Students of engineering are not admitted to the other courses offered in German, except by special permission.

FIRST SEMESTER.

A. Beginner's Course. Thomas's German Grammar Part 2, and a German Reader. *M, Tu, W, F.* Sec. I, at 8. Room 26, U. H. Sec. II, at 3. Room 23, U. H. Mr. DIEKHOFF.

C. Descriptive Prose. *Th, S,* at 8. Room 26, U. H. Mr. DIEKHOFF.

SECOND SEMESTER.

B. Narrative Prose. Easy Stories. Sec. I, *Tu, Th,* at 8. Sec. II, *Th, S,* at 11. Room 23, U. H. Mr. DIEKHOFF.

D. Technical Prose. Schroot's Der Dampf. *W, F,* Sec. I, at 8; Sec. II, at 3. Room 23, U. H. Mr. DIEKHOFF.

ENGLISH AND RHETORIC.

FIRST SEMESTER.

I. Paragraph-Writing. Sec. I, *Tu, Th,* at 3. Room K. Mr. GRAY. Sec. II, *M, W,* at 8. *Th, S,* Sec. III, at 8; Sec. IV, at 9; Sec. V, at 10. Room L. Mr. STRAUSS.

In the first semester Course 1 (except Sec. III, which is arranged for engineering students) is designed especially for candidates for the degree of A. B. and Ph. B.; in the second semester, for all other students.

SECOND SEMESTER.

I. Paragraph-Writing. *Th, S,* Sec. I, at 8; Sec. II, at 10; Sec. III, at 11. Room L. Mr. STRAUSS. *M, W,* Sec. IV, at 3. Room *K.* Mr. GRAY. A fifth section will be formed at *an hour arranged with instructor.*

See note to Course 1 in first semester. Secs. I, II, and III, are designed for engineering students.

MATHEMATICS.

Students of engineering are required to take in order Courses 1, 2, 3, 4, and 6. They are also *required to* take Course 1*b*, unless they have passed a satisfactory examination for admission in plane trigonometry, but no credit toward graduation is given to engineering students for Course 1*b*.

FIRST SEMESTER.

1. Algebra and Analytic Geometry (I). *M*, *Tu*, *W*, *F*. Sec. I, at 8. Room 17, U. H. Mr. COAR. Sec. II, at 8. Room 27, U. H. Mr. GODDARD. Sec. III, at 11. Room 1, T. H. Mr. LYMAN. Sec. IV, at 11. Room 27, U. H. Mr. GODDARD. Sec. V, at 3. Room 27, U. H. Mr. HALL.

1*b*. Plane Trigonometry. *Th*, *S*. Sec. I, at 8. Room 27, U. H. Mr. GODDARD. *Tu*, *Th*. Sec. II, at 9; Sec. III, at 10. Room 7, U. H. Mr. COAR.

3. Calculus. *M*, *Tu*, *W*, *Th*, *F*. Sec. I, at 8. Room H. Assistant Professor ZIWET. Sec. II, at 8. Room 1, T. H. Mr. LYMAN. Sec. III, at 2; Sec. IV, at 3. Room 19, U. H. Dr. GLOVER.

6. Calculus and Mechanics (II). *M*, *Tu*, *W*, *Th*. Sec. I, at 11; Sec. II, at 2. Room H. Assistant Professor ZIWET. Sec. III, at 3. Room 17, U. H. Mr. LYMAN.

SECOND SEMESTER.

2. Analytic Geometry (II). *M*, *Tu*, *W*, *F*. Sec. I, at 8. Room 17, U. H. Mr. COAR. Sec. II, at 8. Room 27, U. H. Mr. GODDARD. Sec. III, at 11. Room 1, T. H. Mr. LYMAN. Sec. IV, at 11. Room 27, U. H. Mr. GODDARD. *M*, *Tu*, *W*, *Th*. Sec. V, at 3. Room 17, U. H. Mr. COAR. Sec. VI, at 3. Room 27, U. H. Mr. HALL.

4. Calculus and Mechanics (I). *M*, *Tu*, *W*, *Th*, *F*. Sec. I, at 8. Room 1, T. H. Mr. LYMAN. Sec. II, at 9. Room H. Assistant Professor ZIWET. Sec. III, at 2; Sec. IV, at 3. Room 19, U. H. Dr. GLOVER.

PHYSICS.

FIRST SEMESTER.

The lectures in physics are given in the lecture room of the Physical Laboratory.

1. Mechanics, Sound and Light. *M*, *Tu*, *W*, *Th*, *F*, at 11. Assistant Professor REED.

Course 1 is open to those who have passed an entrance examination in physics, and to all others who have sufficient preparation. A knowledge of plane trigonometry is indispensable.

3*a*. Physical Laboratory Work for Beginners. *M*, *W*, *F*, 1–3. Dr. GUTHE.

4. Primary and Secondary Batteries. Recitations, *F*, at 8; laboratory work, *once a week.* Dr. GUTHE.

Course 4 must be preceded by Courses 1, 2, 3*a*, and a course in general or analytical chemistry.

5. Electrical Measurements. Lectures and recitations, *Tu*, at 3. Professor CARHART. Laboratory work, *three times a week between* 8 *and* 10, 10 *and* 12, *or between* 1 *and* 3. Assistant Professor PATTERSON and Dr. GUTHE.

Course 5 must be preceded by Courses 1, 2, and 3*a*. A knowledge of calculus is also required.

9. Distribution of Electricity. Lectures, *Tu*, *Th*, at 1. Assistant Professor PATTERSON.

Course 9 must be preceded by Course 8*a*.

13. The Alternate Current Apparatus. *M*, *W*, at 8. Professor CARHART.

Course 13 must be preceded by Course 8*a*.

14. Photometry of Electric Lamps: Palaz. Recitations, *once a week;* laboratory work, *once a week.* Assistant Professor PATTERSON.

SECOND SEMESTER.

2. Electricity and Magnetism. *M*, *Tu*, *W*, *Th*, at 11. Professor CARHART and Assistant Professor Reed.

Course 2 must be preceded by Course 1 and by a course in general or analytical chemistry.

2*a*. Heat. Lecture, *F*, at 11. Recitations, *once a week.* Professsor CARHART and Assistant Professor REED.

Course 2*a* must be preceded by Course 1.

3*a*. Physical Laboratory Work for Beginners. Repetition of Course 3*a*, first semester. Sec. I, *M*, *W*, *F*, 9–11; Sec. II, *M*, *W*, *F*, 1–3. Dr. GUTHE.

8*a*. Electro-Dynamic Machinery. Lectures, *Tu*, *Th*, at 8; laboratory work, *Tu*, *Th*, 2–4. Professor CARHART and Assistant Professor PATTERSON.

Course 8*a* must be preceded by Course 5 and is for students in electrical engineering only.

GENERAL CHEMISTRY.

FIRST SEMESTER.

1. Elementary Inorganic Chemistry, Descriptive and Experimental. Lectures and recitations. *M*, *W*, *F*, at 1. Lower Lecture Room, Me*dical Building.* Mr. HIGLEY.

ANALYTICAL CHEMISTRY AND ORGANIC CHEMISTRY.

The laboratory work requires from two to three hours daily, taken, in the first semester, between 1 and 5 P. M.; in the second semester, between 1 and 6. Permission for forenoon hours is given when necessary.

SECOND SEMESTER.

3. First Steps in Qualative Analysis. *Five hours.* Recitations, *Tu, Th,* at 9; laboratory work, *three times a week.* Professor JOHNSON.

Course 3 is a short course, designed for students of civil, mechanical and electrical engineering.

ASTRONOMY.

A knowledge of logarithms and of spherical trigonometry is required for all courses in astronomy except 1 and 2. In Course 3, however, a short review of spherical trigonometry is given.

EITHER FIRST OR SECOND SEMESTER.

4. Practical Astronomy. Use of portable transit. *Three hours. Hours arranged with instructor.* Observatory. Mr. GILLIS.

Course 4 requires a knowledge of differential and integral calculus.

MINERALOGY.

FIRST SEMESTER.

1. Short Course. Lectures and practice. *Two hours.* Lectures, *Tu, Th,* Sec. I, at 9; Sec. II, at 10; practice, *twice a week, at hours arranged with instructor.* Room 6, T. H. Professor PETTEE.

For Course 1 an elementary knowledge of chemistry is desirable.

SECOND SEMESTER.

1. Short Course. Lectures and practice. *Two hours.* Lectures, *Tu, Th,* at 3; practice, *twice a week, at hours arrranged with instructor.* Room 6, T. H. Professor PETTEE.

For Course 1 an elementary knowledge of chemistry is desirable.

DRAWING.

All the work in drawing is given in the new Engineering Building.

In Courses 4, 7, 8, and 9, attendance in the drawing room on the days indicated is required for *one hour* in addition to the hour specified, and the hours of attendance should be consecutive, if possible.

FIRST SEMESTER.

1. Elementary Drawing. Practice. *Two hours.* Sec. I, *Tu*, *Th*, 2–4 Room 9. Mr. ———. Sec. II, *M*, *F*, 9–11; Sec. III, *M*, *W*, *F*, 2–4. Room 9. Mr. ———.

Sec. I is for students of civil engineering, Sec. II for students of electrical engineering, and Sec. III, which covers the last two-thirds of the semester, is intended for students of mechanical engineering who take Course 4 in surveying in the first third of the semester.

4. Free-hand Drawing; Pen and Ink Drawing; Sketching. *M*, *W*, *F*, at 9, 10, or 11. Room 12. Professor DENISON or Miss HUNT.

9. Sketching of Parts of Machines; Lettering. *M*, *W*, *F*, at 10. Room 14. Professor DENISON.

Course 9 is designed especially for students of mechanical and electrical engineering.

SECOND SEMESTER.

5. Descriptive Geometry. *Three hours.* Rooms 3, 5, 9, and 14. Sec. I, Recitations, *Th*, *F*, at 8; drawing, *W*, 8–10. Sec. II, Recitations, *Tu*, *F*, at 9; drawing, *Th*, 9–11. Professor DENISON. Sec. III, Recitations, *W*, at 8; *Th*, at 9; Drawing *F*, 9–11. Sec. IV, Recitations, *Th*, at 10; *F*, at 8; drawing, *W*, 10–12. Mr. ———. Sec. V, Recitations, W, at 9; *Th*, at 8; drawing, *Tu*, 8–10. Mr.———.

Course 5 must be preceded by Course 1. Sec. I is for students of civil engineering, Sec. II for students of electrical engineering, Sec. III for students of mechanical engineering, Secs. IV and V for others.

6. Shades, Shadows, and Perspective. *Three hours.* *M*, *W*, *F*, at 9, *and such additional time as may be found necessary to complete the work.* Room 10. Professor DENISON.

Course 6 must be preceded by Course 5.

14. Stereotomy. *Two hours.* *Tu*, *Th*, at 9, *and such additional time as may be found necessary to complete the work.* Room 10. Professor DENISON.

Course 14 mnst be preceded by Course 5.

SURVEYING.

All the work in surveying is given in the new Engineering Building.

1. Lectures and Field Practice with Instruments. *Four hours.* *Tu*, *W*, *Th*, *F*, 1–4. Room 5. Professor J. B. DAVIS.

The field practice in Course 1 continues during favorable weather until Christmas.

4. Use of Instruments. *Tu, W, Th,* 9–11. *One hour.* Room 5. Professor J. B. DAVIS.

   Course 4 covers the first *six weeks* of the semester, and is for students of mechanical engineering who take Course 1 in drawing the remainder of the semester.

6. Continuation of Course 5. Phototopography. Field work and drawing. *One hour. M,* 1–4. Room 4. Professor J. B. DAVIS.

   The ability to make photographic negatives will be of service.

SECOND SEMESTER.

2. Continuation of Course 1. Lectures and text-book. *Five hours. M, Tu, W, Th, F,* at 2. Room 9. Professor J. B. DAVIS.

   Course 2 must be preceded by Course 1.

3. Field Work in Camp. *Four weeks, six days each week,* 8–12 *and* 1–5. Professor J. B. DAVIS.

   Except by special permission Course 3 is open only to students who are working for a degree in civil engineering.

5. Topography. Transit and Stadia. Plane Table. Field work and drawing. *Three hours. Thirteen weeks, M, Tu, W, Th,* 1–4. Rooms 5 and 9. Professor J. B. DAVIS.

   Course 5 must be counted as four times a week in making up elections.

CIVIL ENGINEERING.

The work in civil engineering is conducted in the new Engineering Building.

FIRST SEMESTER.

4. Graphical Analysis of Structures. *Tu, Th,* at 9. Room 4. Professor GREENE.

   Course 4 must be preceded by Course 3.

5. Strength and Resistance of Materials. *M, W,* Sec. I, at 9; Sec. II, at 10. Room 4. Professor GREENE.

   Sec. I is for students in civil engineering; Sec. II, for others.

   Course 5 must be preceded by Course 6 in mathematics.

6. Engineering. Theory of construction. *F,* at 9. Room 4. Professor GREENE.

   Course 6 must be preceded by Course 6 in mathematics.

7. Engineering Design. *Five hours. M, Tu, W, Th, F,* 2–5. Room 14. Professor GREENE.

   Course 7 accompanies Courses 5 and 6.

SECOND SEMESTER.

3. Graphical Analysis of Structures. Sec. I, *M*, *W*, at 10; Sec. II, *Tu*, *Th*, at 10. Room 4. Professor GREENE.

   Sec. II is for students in civil engineering; Sec. I, for others.

   Course 3 requires at least a limited knowledge of statics.

8. Engineering. Theory of construction. *M*, *Tu*, *Th*, *F*, at 9. Room 4. Professor GREENE.

9. Hydraulics. Sec. I, *W*, at 9; Sec. II, *W*, at 11. Room 4. Professor GREENE.

MECHANICAL ENGINEERING.

FIRST SEMESTER.

5*a*. Principles of Mechanism. *Three hours.* *Tu*, *Th*, 9–11, *and additional time arranged with instructor.* Room 10. Professor DENISON.

Course 5*a* is for students of mechanical and electrical engineering, and must be preceded by Course 1 or 1*a* in mathematics, and by Courses 1 and 5 in drawing.

5*b*. Principles of Mechanism. *Two hours.* *Tu*, *Th*, 9–11. Room 12. Professor DENISON.

Course 5*b* is for students of civil engineering, and must be preceded by Course 1 or 1*a* in mathematics, and by Courses 1 and 5 in drawing.

8*a*. Prime Movers. Water wheels and steam engines. *Tu*, *Th*, at 10. Room 7. Professor COOLEY and Assistant Professor WAGNER.

8*b*. Prime Movers. Water wheels. *Tu*, at 10. Room 7. Professor COOLEY.

Course 8*b* is intended for those who have taken Course 9; and 8*a* for all others.

Courses 8*a* and 8*b* must be preceded by Course 7*a* or 7*b*.

10. Theory of Machine Design, including Electrical Design. *W*, *F*, at 10. Room 11. Professor COOLEY and Assistant Professor WAGNER.

    Course 10 must be preceded or accompanied by Course 5 in civil engineering.

11. Design of General Machinery. *Three hours.* *M*, *W*, *F*, 1–4. Engineering Laboratory. Professor COOLEY.

    Course 11 should be accompanied by Course 10.

12. Thermodynamics. Hot-air and gas engines, air compressors, and refrigerating machines. *Tu*, *Th*, at 9. Room 7. Assistant Professor WAGNER.

    Course 12 must be preceded by Course 7 and by Courses 1 and 2 in physics.

EITHER FIRST OR SECOND SEMESTER.

All courses in shopwork are under the supervision of Assistant Professor C. G. TAYLOR, to whom application must be made for assignment to sections and arrangement of hours.

Each of the Courses 1*a*, 2*a*, 3*a*, and 4*a* embraces five lectures on workshop appliances and materials, which will be given by Assistant Professor C. G. TAYLOR, *Saturday mornings, hours to be arranged.*

1*a*. Shop Practice. Wood work and pattern work. *Three hours.* Sec. I, *M, W, F*, 9–12; Sec. II, *Tu, Th, S*, 9–12; Sec. III, *M, W, F*, 1–4. Mr. PURFIELD.

2*a*. Shop Practice in Forging. *Two hours. Tu, Th*, Sec. I, 8–10; Sec. II, 10–12; Sec. III, 1–3; *M, F*, Sec. IV, 8–10; Sec. V, 10–12; Sec. VI, 1–3. Mr. ORR.

3*a*. Shop Practice in Iron Work. *Three hours.* Sec. I, *M, W, F*, 9–12; Sec. II, *Tu, Th, S*, 9–12; Sec. III, *M, W, F*, 1–4. Mr. SMOOTS.

4*a*. Shop Practice in Foundry Work. *Two hours.* Sec. I, *Tu, Th*, 9–12; Sec. II, *Tu, Th*, 1–4; Sec. III, *S*, 7½–12½. Mr. WINSLOW.

6*a*. Design of Shop Machinery. *Two hours.* First semester, *Tu, Th*, 9–12. Second semester, Sec. I, *Tu, Th*, 9–12; Sec. II, *W, F*, 9–12. Drawing Room, Engineering Laboratory. Assistant Professor C. G. TAYLOR.

Course 6*a* must be preceded by Courses 1, 5, and 9 in drawing, and preceded or accompanied by Course 5 in mechanical engineering.

The hours announced for Courses 1*a*, 2*a*, 3*a*, 4*a*, and 6*a*, are subject to slight changes to accommodate students. These courses may be elected as 1*b*, 2*b*, 3*b*, 4*b*, and 6*b*, by advanced students. *Hours arranged with the instructor.*

SECOND SEMESTER.

7*a*. Dynamics of Machinery. *M, W*, Sec. I, at 8; Sec. II, at 11. Room 7. Assistant Professor WAGNER.

7*b*. Dynamics of Machinery. *One hour. First half of semester. M, W*, Sec. I, at 8; Sec. II, at 11. Room 7. Assistant Professor WAGNER.

Course 7*b* is the same as the first half of Course 7*a*, and is intended for students of civil engineering.

Courses 7*a* and 7*b* must be preceded by Course 6 in mathematics, and by Course 1 in physics.

9. Steam Engines. Valve gears. *M*, *W*, *F*, at 9. Room 7. Assistant Professor WAGNER.

   Course 9 must be preceded or accompanied by Course 7*a* or 7*b*.

13. Machinery and Mill Work. *Tu*, *Th*, at 10. Room 11. Professor COOLEY.

14. Design of Engines and Boilers. *Two hours*. *Tu*, *Th*, 1–4. Engineering Laboratory. Professor COOLEY.

15. Steam Engineering. Practical work in the laboratory. *Three hours*. *M*, *W*, *F*, 1–4. Professor COOLEY and Assistant Professor WAGNER.

   Course 15 must be preceded by Course 8.

METALLURGY.

SECOND SEMESTER.

1. Fuel and Refractory Material, Iron and Steel. *M*, *W*, *F*, at 11. Professor E. D. CAMPBELL.

   Course 1 must be preceded by Course 1 or Course 3 in analytical chemistry, or by Course 1 in general chemistry.

For additional courses (not prescribed), in civil, mechanical and electrical engineering, in mathematics, physics, chemistry, drawing, surveying, astronomy, metallurgy, geology, languages, etc., see ANNOUNCEMENT OF DEPARTMENT OF LITERATURE, SCIENCE AND THE ARTS.

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Department of Engineering

ANNUAL ANNOUNCEMENT

AND

REGISTER OF ALUMNI

FOR

1896-97

ANN ARBOR, MICH.:
PUBLISHED BY THE UNIVERSITY
1896

Requirements for Admission in 1898, See Page 35

UNIVERSITY OF MICHIGAN

Department of Engineering

ANNUAL ANNOUNCEMENT

AND

REGISTER OF ALUMNI

FOR

1896-97

ANN ARBOR, MICH.:
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1896

CALENDAR.

1896.	
June 20, 22.	Examination for Admission to the Department of Engineering.
June 23.	Class Day.
June 25.	Commencement in all Departments of the University.
June 23 to Sept. 30.	Summer Vacation.
June 29 to Aug. 7.	Summer School.
Sept. 23–27.	*Examination for Admission to the Department of Literature, Science, and the Arts.*
Oct. 1.	First Semester Begins in all Departments of the University.
Nov. —	Thanksgiving Recess of three days, beginning Tuesday evening, in all Departments of the University.
Dec. 18.	(Evening.) Holiday Vacation begins in all Departments.
1897.	
Jan. 5.	Exercises Resumed.
Feb. 13.	(Evening.) First Semester Closes.
Feb. 22.	Second Semester Begins.
April 16.	(Evening.) Recess begins, ending April 20 (Evening).
July 1.	Commencement in all Departments of the University.

THE INLAND PRESS.

Department of Engineering.

FACULTY.*

JAMES B. ANGELL, LL.D., PRESIDENT.

ALBERT B. PRESCOTT, PH.D., M.D., *Director of the Chemical Laboratory, Professor of Organic Chemistry, and Dean of the School of Pharmacy.*

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EDWARD D. CAMPBELL, B.S., *Junior Professor of Metallurgy and Metallurgical Chemistry.*

FRED N. SCOTT, PH.D., *Junior Professor of Rhetoric.*

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*In this list are included a few other officers and instructors with whom engineering students are likely to elect work.

ALEXANDER ZIWET, C.E., *Junior Professor of Mathematics.*

PAUL R. DE PONT, A.B., B.S., *Assistant Professor of French, and Registrar of the Department of Engineering.*

CLARENCE G. TAYLOR, B.S., *Superintendent of Shops in Engineering Laboratory.*

GEORGE W. PATTERSON, JR., A.M., S.B., *Assistant Professor of Physics.*

FRANK C. WAGNER, A.M., B.S., *Assistant Professor of Mechanical Engineering.*

JOHN O. REED, PH.M., *Assistant Professor of Physics.*

JOSEPH L. MARKLEY, PH.D., *Assistant Professor of Mathematics.*

MAX WINKLER, PH.D., *Assistant Professor of German.*

MORITZ LEVI, A.B., *Assistant Professor of French.*

ELMER A. LYMAN, A.B., *Instructor in Mathematics.*

GEORGE O. HIGLEY, M.S., *Instructor in General Chemistry.*

DAVID M. LICHTY, M.S., *Instructor in General Chemistry.*

JOHN R. EFFINGER, JR., PH.M., *Instructor in French.*

ERNST H. MENSEL, A.M., *Instructor in German.*

ARTHUR G. HALL, B.S., *Instructor in Mathematics.*

JONATHAN A. C. HILDNER, A.M., *Instructor in German.*

CLARENCE G. WRENTMORE, B.S., *Instructor in Descriptive Geometry and Drawing.*

KARL E. GUTHE, PH.D., *Instructor in Physics.*

TOBIAS DIEKHOFF, A.B., *Instructor in German.*

JAMES W. GLOVER, PH.D., *Instructor in Mathematics.*

LOUIS A. STRAUSS, B.L., PH.M., *Instructor in English.*

EDWIN C. GODDARD, PH.D., *Instructor in Mathematics.*

CHARLES R. GILLIS, PH.B., *Instructor in Astronomy.*

EDGAR E. BRANDON, A.B., *Instructor in French.*

HERBERT J. GOULDING, B.S., *Instructor in Descriptive Geometry and Drawing.*

HENRY L. COAR, A.M., *Instructor in Mathematics.*

VICTOR E. FRANCOIS, *Instructor in French.*

ALICE L. HUNT, *Assistant in Drawing.*

CHARLES H. GRAY, B.L., *Assistant in English.*

EDWIN C. ROEDDER, A.M., *Assistant in German.*

CARLTON R. ROSE, PH.B., *Assistant in Qualitative Chemistry.*

Special Assistants in the Engineering Laboratory.

ROBERT A. WINSLOW, *Foundry.*

JOHN M. SMOOTS, *Iron Room.*

HORACE T. PURFIELD, *Wood Room.*

THOMAS ORR, *Forge Shop.*

Department of Engineering.

GENERAL INFORMATION.

The University of Michigan is a part of the educational system of the State, and derives from the State, in one way or another, the greater part of its revenue. The University comprises the Department of Literature, Science, and the Arts, and six professional schools, each of which has its own Faculty and issues each year a separate departmental announcement. The various faculties aggregated in 1895–96 one hundred and thirty-four officers of instruction, besides numerous assistants, some of whom participate in the work of teaching. More than twenty-nine hundred students, representing forty-five States and Territories, and thirteen foreign countries, were in attendance.

While provision was made, by the legislative act under which the University was organized in 1837, for instruction in engineering, work was begun in this line in 1853, and the first degrees were conferred in 1860. The engineering courses were included in the Department of Literature, Science, and the Arts, until the close of the collegiate year 1894–95. At that time the Department of Engineering was established by the Board of Regents.

Persons who wish to become professional engineers are offered here thorough courses of study in civil, mechanical, and electrical engineering. The work extends through four years. The aim of the Department is to lay a foundation of sound theory, sufficiently broad and deep to enable its graduates to enter understandingly on the further investigation of the several specialties of the profession; and at the same time to impart such a knowledge of the usual professional practice as shall make its students useful in any position to which they may be called. While the adaptation of theory to practice can be thoroughly learned only by experience, there are many matters in which the routine work of an engineering field party, office, or drafting room can be carried out on a greater or less scale in a training school. The technical branches are under the direct care of those who have had professional experience as well as a full scientific training, and in all particulars the courses embody as close an imitation of the requirements of active labor as the instructors who have the several branches in charge can devise.

The college year extends from the first day of October to the Thursday following the last Wednesday in June.

REQUIREMENTS FOR ADMISSION TO THE DEPARTMENT OF ENGINEERING.

[For admission to advanced standing, see page 9.]

[For admission of students not candidates for a degree, see page 10.]

Candidates for admission must be at least sixteen years of age, and must present satisfactory evidence of good moral character. They must bring credentials from their last instructor, or from the last institution with which they have been connected.

Unless admitted on diploma from an approved school (see page 11), any student who desires to become a candidate for a degree must pass examinations in the subjects described below. Before entering upon the examination each applicant must present his credentials to the Dean of the Department at his office in the Engineering Building.

ADMISSION OF CANDIDATES FOR A DEGREE.

The subjects on which applicants for admission to any of the courses leading to a degree in engineering will be examined are as follows:

English Language, Composition and Rhetoric.—*Grammar.*—Selections for analysis and parsing will be set, arranged to test the applicant's knowledge of the leading facts of English Grammar. To meet this requirement, a review of the subject should be had during the last year of the preparatory course.

Composition and Rhetoric.—The purpose of the examination in composition is to test the applicant's ability to write good English. To this end he will be asked to write two essays of not less than two hundred words each, one upon a subject drawn from books he has read, and the other upon a subject drawn from his experience or observation. The language of these essays must be grammatical and clear. The spelling, punctuation, and capitalizing must be correct. The applicant must show ability to discriminate in the use of words and to construct well organized sentences and paragraphs. A topical outline should accompany each essay.

As preparation for this requirement, sustained and regular practice in writing is earnestly recommended. The student should prepare numerous written exercises throughout the four years of the high school course, and a sufficient number of these exercises should be corrected by the teacher and revised by the student to secure the desired accuracy. The subjects upon which the student writes should not be drawn exclusively from literature; a considerable proportion of them should be taken from the student's every-day experience; and topics should be so distributed as to give proper training in the various types of discourse, namely, description, narrative, argument, and exposition. The student should be grounded in the essentials of rhetoric, but those principles should receive emphasis which are most likely to be of service to him in his practice in writing, such as the principles of sentential structure, paragraphing, and the outlining of the essay. The correction of stock specimens of bad English is not recommended and will form no part of the entrance requirement.

It is further recommended that the reading of English classics and the memorizing of notable passages, both in prose and poetry, should form a regular exercise throughout the whole preparatory period. This is all-important for the development of a correct taste in language and literature. These readings should be connected, in reasonable measure, with the lives and characters of the authors read and with the history of their times. A good knowledge of the chronological order and of the leading characteristics of the principal modern English writers should be aimed at. Care should be taken not to overload the text of these classics with a mass of irrelevant and petty learning. Many of the "school classics" now in use are over-edited.

The books, from which subjects for compositions will be chosen in the year named, are here given. The applicant should make himself familiar with the plot, incidents, and characters of each work. Equivalents will be accepted.

1896. Shakespeare's *A Midsummer Night's Dream*, or *The Merchant of Venice;* Defoe's *Journal of the Plague Year;* Scott's *Woodstock;* Longfellow's *Evangeline,* George Eliot's *Silas Marner;* Irving's *Tales of a Traveller.*

1897. Shakespeare's *As You Like It*, or *The Merchant of Venice;* Defoe's *Journal of the Plague Year;* Scott's *Marmion;* Longfellow's *Evangeline;* George Eliot's *Silas Marner;* Irving's *Tales of a Traveller.*

1898. Milton's *Paradise Lost*, Books I and II; Pope's *Iliad*, Books I and XXII; Goldsmith's *The Vicar of Wakefield;* Southey's *Life of Nelson;* Lowell's *The Vision of Sir Launfal;* Hawthorne's *The House of Seven Gables.*

1899. Chaucer's *The Knight's Tale*, or Dryden's *Palamon and Arcite;* Milton's *Paradise Lost*, Books I and II; Pope's *Iliad*, Books I, VI, XXII, and XXIV; The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* De Quincey's *Revolt of the Tartars;* Cooper's *The Last of the Mohicans;* Lowell's *The Vision of Sir Launfal;* Hawthorne's *The House of Seven Gables.*

In addition to the books just named, it is expected that several other English Classics will be read each year.

English Literature.—Daily recitations for at least one year will be requisite. Stopford A. Brooke's Primer, or any other manual may be used for an outline of the subject. As much time as practicable should be given to the careful reading of representative authors in each period.

Mathematics.*—*Algebra.*—Fundamental Rules, Fractions, Simple Equations, Involution and Evolution, the Calculus of Radicals, and Quadratic Equations, as given in Olney's Complete School Algebra, or an equivalent in other authors.

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* Students entering at the beginning of the second semester (February 22, 1897), should be prepared in the mathematics of the first semester in addition to the other requirements for admission.

Geometry.—Beman and Smith's Plane and Solid Geometry, or an equivalent in other authors.

Trigonometry.—Plane Trigonometry as given in Olney's Elements of Trigonometry, or an equivalent in other authors.

N. B.—It is very desirable that High Schools whose graduates are received on diploma arrange their courses so as to include a portion of both algebra and geometry in their last preparatory year. Students who do not come from diploma schools should take a similar review if they expect to succeed in the study of mathematics in the University.

Physics.—An amount represented by Carhart and Chute's Elements of Physics. Laboratory work in physics is urgently advised, though not required; but students who have completed a course in laboratory practice, may expect to derive advantage from it if they take work in the physical laboratory in the University.

History.—Myers's General History, or an equivalent, and the History of the United States as far as the close of the Revolutionary War.

Chemistry, Geology, Zoology, Physiology, Physical Geography and Astronomy.—The applicant may offer any *two* of these subjects. The requirements, intended to cover a half year's work in each subject, are as follows:

Chemistry.—Freer's Elementary Chemistry, or an equivalent amount in Remsen's Introduction to the Study of Chemistry.

Geology.—Winchell's Geological Studies.

Zoology.—Packard's Zoology, Briefer Course, or Nicholson's Manual of Zoology.

Physiology.—Martin's The Human Body, Briefer Course.

Physical Geography.—Tarr's Elementary Physical Geography, especially chapters 9 to 21 inclusive, or an equivalent.

Astronomy.—Newcomb and Holden's Astronomy, Briefer Course, Young's Elements of Astronomy, or an equivalent. A knowledge of the principal constellations is required.

French, German or Latin.—Applicants may offer French, German, or Latin, one of these three languages being required. The requirements in each are as follows:

French.—The whole subject of French Grammar. The applicant will be expected to read at sight easy French, and to translate correctly into French simple English sentences. Two years ought to be given to this study, the first year being spent on the grammar, and the second devoted to reading good modern French, accompanied by grammatical analysis and exercises in writing. The texts read should be chiefly narrative and conversational prose; modern, rather than classic, dramas should be read.

German.—(1) Ability to pronounce German correctly and to read it fluently with the proper intonations. (2) Thorough familiarity with the every-day facts of the grammar, to be evinced by putting illustrative English phrases and sentences into German. (3) Sufficient miscellaneous prose reading—say four hundred pages—so that the applicant will be able to construe at sight, and put into good English, a passage of moderately difficult German prose, either narrative or dialogue. (4) A careful study of one classical drama, Schiller's Tell being recommended.

Latin.—Jones's First Latin Book, or an equivalent amount in any other introductory text-book, four books of Caesar's Gallic War, and one of the orations of Cicero. It is expected that at least two years will be given to preparation in Latin.

ADMISSION TO ADVANCED STANDING.

1. Graduates of the Department of Literature, Science, and the Arts of this University, or of any other reputable college, are admitted without examination to advanced standing as candidates for a degree in engineering, and are held only to the completion of the special requirements for graduation in the several courses (see page 32). These requirements can be completed in two years. A knowledge of differential and integral calculus, of analytical mechanics, of elementary drawing, and of descriptive geometry, is needful for the advanced work.

2. Students who have completed at least one year's college work in an approved college, and who bring explicit and official certificates describing their course of study and scholarship, and testifying to their good character, will be admitted to advanced standing without examination, except such as may be necessary to determine what credit they are to receive for work done in the college from which they have come.

3. Students who have not completed at least one year's college work in an approved college, but who, previously to entering this department of the University, have pursued studies beyond those required for admission, may be admitted to advanced standing on passing the regular entrance examinations, and examinations in such undergraduate studies as they may ask to be credited with in advance.

RULES RELATING TO ADMISSION TO ADVANCED STANDING.

a. Credits must be secured before the fifteenth of December or (if the candidate be matriculated after that date) before the tenth of April.

b. No credits will be given for advanced standing after the dates named in (*a*).

c. An account once closed cannot be reopened without special permission of the Faculty.

d. All students, whether candidates for a degree or not, who apply for advanced standing on the conditions stated in paragraphs (2) and (3) above, must present to the Registrar a statement showing the amount of work done in the subjects in which credit is asked.

e. The application for advanced standing should be made to the Registrar immediately after matriculation; and the Registrar will furnish a blank form for presentation to the professors in charge of the several subjects named in the blank.

ADMISSION OF STUDENTS NOT CANDIDATES FOR A DEGREE.

Persons who desire to pursue studies in this department, and do not desire to become candidates for a degree, are admitted on the following conditions:

1. All persons under twenty-one years of age must pass the regular entrance examinations.
2. Persons over twenty-one years of age must show that they have a good knowledge of English and are otherwise prepared to pursue profitably the studies they may desire to take up.
3. Should a student who enters under the preceding provision (2) subsequently become a candidate for graduation, he must pass the regular entrance examinations, at least one year previous to the time when he proposes to graduate.
4. Students not candidates for a degree who wish credit for studies pursued before admission are referred to the rules relating to advanced standing given above.
5. Students not candidates for a degree are expected to attend the lectures, recitations, and examinations in the branches prescribed for the regular students, and are required to take enough work to occupy them profitably.

TIMES OF EXAMINATIONS.

An examination for admission to the Department of Engineering will be held on Saturday and Monday, June 20 and 22, 1896, and another beginning on Wednesday, September 23, and continuing through the Thursday, Friday, Saturday, and Monday following. The examinations will begin at nine o'clock A. M. of each day. Applicants may take their examinations at either of these times, or may take a part in June and a part in September. In either case it is particularly desired that they present themselves on the first day of the examination.

At the June examination the subjects for Saturday will be: Mathemathics, Latin, French, German, Zoology, Physiology, Astronomy, Physical Geography, Geology. For Monday: English Language, English Literature, History and Civil Government, Physics, Chemistry.

In September the examinations will be conducted in accordance with the following scheme:

	WEDNESDAY.		THURSDAY.		FRIDAY.		SATURDAY.		MONDAY.	
	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
Mathematics	9 00	2 00	9 00	2 00	....	....	9 00	2 00	9 00	....
Latin*	....	....	9 00†	....	....	....	9 00	....	....	....
English Language*	....	4 00	....	4 00	....	4 00	....	....	....	4 00
English Literature*	....	....	....	2 00	....	....	....	3 00	....	....
History and Civil Government*	....	....	....	....	....	2 00	....	....	....	2 00
French	....	....	....	2 00	....	2 00	....	2 00	....	....
German	9 00	....	9 00	....	9 00	....	9 00	....	9 00	....
Zoology	....	....	....	....	....	....	....	....	....	2 00
Physiology*	....	....	....	....	....	....	....	....	11 00	....
Geology	....	....	....	....	....	....	....	4 00	....	....
Astronomy	....	....	....	....	....	....	....	....	....	3 00
Physical Geography*	....	....	....	....	....	....	9 00	....	....	....
Physics*	....	....	11 00	....	9 00	....	....	....	....	4 00
Chemistry*	....	....	....	....	....	....	....	2 00	....	....

ADMISSION ON DIPLOMA.

Students presenting graduation diplomas from any of the schools approved by the Faculty of the Department of Literature, Science, and the Arts, are admitted without further examination to the Department of Engineering on the conditions stated below.

The privilege of sending pupils for admission on diploma, originally limited to approved schools in Michigan, has been extended to include schools in other States.

On request of the school board in charge of any school, the Faculty will designate a committee to visit the school and report upon its condition. Usually the committee will consist of members of the Faculty; but whenever, owing to the great distance of a school from Ann Arbor, or for any other reason, this is impracticable, other persons may be designated to perform, under the direction of the Faculty, the work of inspection.

If the Faculty are satisfied from the report of their committee that the school is taught by competent instructors, and is furnishing a good preparation to meet the requirements for admission of candidates for any one of the degrees offered, then the graduates from *the approved preparatory course or courses* will be admitted without further examination, and permitted to enter upon such undergraduate work as the preparatory studies contemplated. They must present to the Dean of the Department, within a year and three months after their graduation, the diplomas of their school board. They must also present certificates from the school superintendent or principal, stating that they have sustained their examinations in all the studies prescribed for admission of candidates for some one degree, and are recommended for admission to the University. They will be required to appear at once in their places; otherwise they can be admitted only upon examination.

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* Examination in writing. † Consultation hour.

The schools which shall be approved shall be entitled to send their graduates on diploma for a period of three years (inclusive of the year of visitation) without further inspection, provided the Faculty are satisfied that within this period no important changes affecting the course of study and the efficiency of the instruction make another inspection necessary. Otherwise, the Faculty reserve the right to require another inspection if the relation between the school and the University is to be maintained. Should the authorities of any school at any time within this period desire that a committee of inspection visit their school, the Faculty will always grant such a request if practicable.

The superintendent of each approved school is expected to send to the President, annually, at a date not later in the year than March first, a catalogue of the school; or, if no catalogue is published, he is expected to send a statement, giving the names of the teachers, the number of pupils, and a description of the course of study.

THE WORK OF THE DEPARTMENT.

The studies pursued in the earlier part of the course comprise, in *Mathematics*, algebra, trigonometry, analytic geometry, and the elements of differential and integral calculus; in *French* and *German*, an amount covering in all about a year and a half of study; in *English*, a course in higher English grammar and composition; in *Physics* and *Chemistry*, the study of the elementary principles; and in *Drawing*, practice in geometrical and in mechanical drawing, and in the study of descriptive geometry.

The more technical subjects are taken up in the latter part of the course. Some of these subjects are of equal value to all classes of engineering students, such as analytical and applied mechanics, the strength and resistance of materials, and the metallurgy of the useful metals, especially iron and steel; others are adapted more particularly to the wants of the special students in the several courses. Their general scope may be seen from the following descriptive outline.

DESCRIPTION OF COURSES.

1. **Drawing.**—A very complete course in mechanical drawing is given, embracing plane projection drawing, isometric drawing, descriptive geometry, and the elementary principles of coloring and shading, with original problems executed in the drawing room. Examples from

numerical data are always given when suited to the conditions of the problem in hand. Students in mechanical engineering are required to sketch pieces of machinery, and afterwards to make working drawings suitable for use in the shop. The plans of surveys, plane-table work, maps, designs in engineering construction, and the thesis drawings naturally come under this head. Instruction is also given in free-hand drawing, topographical drawing, ornamentation and lettering, shades and shadows, linear perspective, and drawing for stone cutting. The work in drawing occupies the student a part of almost every day throughout the course.

2. **Surveying.**—The work in surveying covers one full year and includes text-book work, lectures, recitations, and field practice. The theory of instruments and all the operations of surveying, laying out work, and computing, are explained in detail, and each student is required to make plats or maps and the necessary calculations of actual surveys. A varied and ample supply of instruments is available for use. The classes have practice in steel-tape measurements, ranging lines, measuring angles, running levels and curves of various kinds, and the measurement of earthwork; they make surveys, traverse them, calculate contents, divide areas, and, in general, perform the work of highway, street and railroad surveying. They are given practice in every step of topographical surveying and drawing. They make surveys with the transit and stadia, plane-table, photographic camera, and other instruments; they reduce the notes, develop and finish the pictures, plot the work, and make finished drawings of all field operations. They also determine the meridian and take observations for latitude. The work is done during the fall months.

In the month of June the class is taken into the field as a railroad party for a period of four weeks continuously, where, under competent supervision, it goes through all the field work for a projected line, up to the point of actual construction, such as reconnoissance, preliminary and location survey, cross-sectioning, staking out, contouring, and topography. Plans and profiles, carefully made in the field by the students from the notes of the party, complete this portion of the subject, and serve to fix the practical application of the principles obtained from the text-books and lectures. In the above work are usually included a plane-table survey, triangulation, and some hydrography when the selected locality is favorable.

Instruction by lecture, text-book, and recitation is given, covering the special field of city engineering, and pointing out its connection with, and dependence upon, other branches of engineering work. The city engineer's duties with respect to various matters of public concern are explained. Among the subjects treated in this connection are streets and their present uses, sewers, waterworks, public franchises, assessments, bridges, building inspection, fires, and lighting. The instruction is not technical, but, as the work of the modern city engineer covers a wide field of engineering, an attempt is made to present some of the controlling relationships and to supplement and apply to this service what is taught in other parts of the course.

The principal text-books used are Johnson's Surveying, Searle's Field Engineering, and Byrne's Highway Construction. All the more important books of reference are easily accessible to the student.

3. **Strength and Resistance of Materials.**—A course of recitations and lectures continuing through the first half-year is devoted to this subject, and is attended by all the engineering students. The action of the different materials under applied forces, the distribution of stress, and the proper proportions to be given to the different parts of structures in order that they may safely fulfil their several functions, are carefully studied.

Tests of wood, iron, steel, cement and other building materials are made in the Engineering Laboratory.

4. **Theory of Structures.**—Roof and bridge trusses, in wood and iron; arches, in wood, iron, and stone; trestles; brick and stone masonry; foundations; tunnels; and, in general, the whole theory of structures are discussed. In this course, as in the preceding (3), Rankine's Civil Engineering is used as a text-book, supplemented by full explanations, additional notes, lectures, examples, and problems.

A complete course of instruction is also given in the graphical analysis of roof and bridge trusses and arches, as recently developed and applied. The student is made familiar with both the analytical and graphical methods of treatment and thus possesses ready proof of the accuracy of his calculations.

5. **Hydraulics.**—The law of the flow of water through orifices and pipes and over weirs; the gauging of streams and rivers; the designing of works for water supply, drainage, and sewerage; the laying out of canals; and the subjects of river and harbor improvements are treated in this course.

6. **Machinery, Prime Movers, and Millwork.**—A course of instruction is given in mechanism, or the general principles of machinery, involving the study of gearing, screws, cranks, and levers, and the dynamics of machinery. In the study of prime movers, special attention is given to turbine and other water motors, and to steam engines. In the theory of machine construction, problems involving the strength and design of machines, and the materials used in their construction, and also involving the application of the principles of electricity, are studied at length, in connection with such examples as illustrate the best practice.

The instruction in millwork covers the distribution of power and the arrangement of shafting and machinery in manufacturing establishments. Practical problems involving the strength of shafting, belting, and gearing are fully treated. Tests are made to determine the efficiency of machines, and the value of lubricants.

7. **Designs in Engineering and in Machine Construction.**—Contemporaneously with the study of theory students are required to work out problems in design. They are furnished with the usual data for a design, and the kind or type of structure or machine is indicated. They are then expected to make the necessary calculations, paying particular attention to proportioning the different parts so as to secure strength, simplicity, and effect, and to present at a specified date complete working drawings, giving full details, accompanied by bills of materials, estimates, and specifications.

8. A course in **Thermodynamics** embraces the study of the principles governing the action of heat engines in general, hot-air and gas engines, air compressors, compressed-air engines, and refrigerating apparatus.

9. **Steam Engineering.**—The work in this branch covers the practical use of steam. Furnaces and boilers are studied with reference to proper combustion of fuel; to securing maximum evaporative efficiency; and to proportioning the parts for strength, durability, and accessibility for cleaning and repairs. The care and management of engines and boilers, both in use and out of use, are fully considered. A study is made of the principal steam pumps and pumping engines. The practical application of steam to heating and ventilating purposes is treated by lectures, and by inspection of actual plants. Tests are made to determine the value of fuels, quality of steam, and the efficiency of furnaces, boilers, and engines.

10. **Shop Practice.**—See also Engineering Laboratory, p. 19. Instruction is given in the principles governing the action of cutting tools and the principal machine and hand tools used in the shop. Lectures are given on pattern making, moulding, and founding, covering the principal features of each.

The *Shop Practice* in the various work shops covers the application of principles previously studied. It comprises the actual manipulation of the tools used in working metal and wood, and in moulding. The student is required to do work in pattern making and moulding in green sand, in dry sand, and in loam, and to charge and have the management of the cupola and brass furnace during the operations of casting. Careful attention is given to the operations of founding and to making composition metals for specific purposes. The student is also required to put in practice, at the blacksmith's forge, his knowledge of the elementary principles of forging, and to forge and temper his own cutting tools. By working with iron and steel of different qualities the student becomes familiar with all grades of those materials. Practice is also afforded in soldering, brazing, and steam-fitting.

Courses in elementary and machine drawing go hand in hand with the above.

Advanced work in the shops can also be taken by those who wish to become especially skilled in such lines, or who desire to fit themselves for instructors in Manual Training Schools and work shops of this character.

11. **Marine Engineering and Naval Architecture.**—The instruction in this branch comprises the study of marine steam engines and propelling instruments, the hydraulics of ship-building, buoyancy, metacentre, stability and trim, weight and centre of gravity, waves and rolling, structural strength, speed and resistance, propulsion by sails and steam engines, laying-off and taking-off, and other topics.

12. **Metallurgy.**—A course of instruction by lectures and recitations is given upon the subjects of fuel, refractory material, iron, and steel. The lectures are illustrated by charts and drawings of furnaces and appliances used, and by samples of furnace products.

13. **Electrical Engineering.**—The special electrical courses, additional to the elementary study of the subject, are devoted to primary and secondary generators, electrometallurgy, electrical units and methods of measurements, dynamo-electric machinery, the alternate-current transformer, arc and glow lamps, photometry, and the distribution of electricity and transmission of power. In addition, elective courses in mathematical electricity are offered.

The laboratory work in electricity is devoted mainly to the testing of primary and secondary batteries, to practice in making electrical measurements of precision by all the best methods, to setting up dynamos, motors, and storage batteries and testing them for efficiency, to the investigation of transformers for efficiency and for hysteresis curves, to photometry of both arc and glow lamps, and to special investigations connected with the preparation of a thesis.

14. **Visits of Inspection.**—As often as practicable, visits are paid to neighboring manufacturing establishments, and to electric-light and electric-power stations, for the purpose of acquiring a knowledge of the methods employed in building, in the construction of bridges, machinery, and ships, and the best practice in electrical manufacturing and engineering on a large scale.

EXAMINATIONS.

Examinations, usually in writing, are held at the end of each semester, but the classes are liable to be examined at any time, without notice, on any portion of their previous work.

FACILITIES FOR INSTRUCTION.

The collections for illustrating the instruction given comprise models, drawings, photographs, lithographs, and blue prints representing trusses, arches, and details of construction in iron, wood, and stone; also shapes of iron, working models of turbines and engines, and working drawings of a number of bridges. These collections are receiving additions from year to year, by gift and purchase, and are invaluable to the student.

Tests of engines and boilers, and of machinery in general will be made on request, and the profit of such work devoted to extending the facilities of the engineering laboratory. The data of all experiments and tests made are kept in the laboratory records.

All the laboratory work is on a practical basis, and is done as nearly as possible as it would be done in any well arranged manufacturing establishment. There is also a metallurgical laboratory connected with the chemical laboratory, supplied with assay furnaces and other appliances. The latest and best books on professional subjects are added yearly to the library, where they are accessible to all; and frequent references are made to them in the class room as the various subjects are brought forward.

PHYSICAL LABORATORY.

The basement of the physical laboratory has a German rock-asphaltum floor, with heavy stone-capped piers in every work-room, and is devoted entirely to experimental work in electricity and magnetism. The engine room contains a 10″ by 14″ Russell horizontal engine with countershaft and friction clutch, and Edison shunt-wound dynamo of 5,000 watts capacity, a Sperry and a Brush 10-arc light machine, with lamps for both, a Gramme machine of 5,000 watts made in 1877, a Fort Wayne 300-light alternator, with converters and all the appliances for a complete alternating plant, a Fisher 225-light constant potential machine, and a floating dynamometer. In an adjacent room are placed electrodynamometers, ammeters, voltmeters, a wall resistance of iron wire constructed to absorb about 35 H-P of electrical energy, and a bank of 225 incandescent lamps. The photometric room, with blackened walls, and lighted only artificially, is also adjacent to the engine room.

A battery room, well ventilated and lighted, and supplied with water, contains a large storage battery. Five smaller work rooms are fitted with the usual appliances for electrical measurements.

On the first floor are a commodious lecture room, an apparatus room, a general laboratory for elementary work, a balance room, a mercury room, and two rooms for a private laboratory.

The laboratory is supplied with the most modern apparatus from the best American and European makers. In sound, it includes tuning forks and resonators from Koenig of Paris; in light, a spectrometer with 12-

inch divided circle, an ophthalmo-spectroscope from the Geneva Society, an optical bench, with accessories, from Duboscq, a Zeiss focometer, a Zeiss spectrometer, and a polarimeter from Schmidt and Haensch; in electricity, galvanometers and resistance boxes, up to 250,000 units, from Edelmann, Hartmann & Braun, Elliott Brothers, Nalder Brothers & Co., and Queen & Co., besides condensers, voltmeters, and ammeters; also Lord Kelvin's graded galvanometers, a centi-ampere, a deci-ampere, and a deka-ampere balance made by White, of Glasgow. Among the standards are standard cells, a standard 100-ohm, a 10-ohm, and three 1-ohm coils, two standard condensers, and Ayrton and Perry's standard of self-induction, with a secohmmeter by Nalder Brothers.

The work in the laboratory is entirely quantitative in character, but provision has been made for illustrating the general principles of physics in the lecture courses.

CHEMICAL LABORATORIES.

The chemical laboratories provide for classes in general, analytical, organic, and physical chemistry, in pharmacy, in chemical technology, and in metallurgical assaying. Opportunities are given for original research in the several branches of chemical science and for independent investigations. In the course of the year, classes are formed in thirty-eight distinct courses of study. In the greater number of these courses the method of work combines training in laboratory operations with study for recitations and instruction by lectures,—the three requirements being united in one course.

The chemical building contains in all about 37,000 square feet of floor space. Besides the rooms for recitations, storage, administration, etc., the laboratories for students have an area of about 25,000 square feet.

The laboratory of general chemistry is separately organized. Courses in elementary inorganic chemistry, as well as in the advanced branches of the science are offered; research work both in inorganic and in organic general chemistry is also arranged for a limited number of students. Modern apparatus is provided for all the varieties of work that are liable to be undertaken.

The laboratories of analytical chemistry, organic chemistry, pharmacy, and chemical technology are all under one organization and are supplied in common. There are separate work rooms for qualitative analysis, quantitative analysis, iron and steel analysis, pharmaceutical preparations, organic preparations, organic analysis, medical chemistry, and assaying of ores,—as well as rooms for the weighing-balances and instruments of precision, for gas analysis, and for optical work. There are separate rooms for original research. The building contains two lecture rooms, two recitation rooms, and a museum with collections for instruction in chemistry, pharmacy, pharmacognosy, and chemical technology. In the ventilation of the work rooms the supply of fresh air is enforced by driving fans, and the removal of foul air is effected by strong draught flues, with which, also, work-hoods are connected.

The chemical laboratories are open throughout the college year to all students of the University, and are regularly used by all departments except the Department of Law. They are also open to any person who wishes to pursue special studies therein, provided he complies with the conditions for admission to that department of the University to which the desired special studies properly belong.

Three hundred and eighty students are engaged in these laboratories at the same time, each at a table provided for one worker. During the year, from 600 to 800 students complete from one to four courses of study each in the various branches of chemistry. The students engage in chemical work as it is needful for their different purposes—the pursuit of science, or the preparation for teaching, for the several professions applying chemistry, and for the various chemical arts and industries.

ENGINEERING LABORATORY.

The Engineering Laboratory contains about 20,000 square feet of floor space. It is divided into rooms as follows:

The Mechanical Laboratory, 40 by 80 feet, is devoted to experimental work in connection with the testing of engines, boilers, pumps, indicators, belting, gearing, lubricants, and strength of materials, and to such original work as can be undertaken with advantage. The work also extends to the testing of engines, boilers, and water-wheels of neighboring mills and electric plants. The Knowles and the Gordon pumping engines at the City Water Works have been fitted up by the company with especial reference to the convenience of engineering students in making tests. The equipment contains, among other things, a 100,000-pound Olsen testing machine; a 2,000-pound cement testing machine; Thurston and Ashcroft oil testing machines; a Stirling boiler for high pressure; a high speed automatic engine; a Corliss engine; a Rider hot-air engine; Wheeler and Wainright surface condensers; an Alden absorption dynamometer; a Giddings traction recording dynamometer; an Emerson power-scale; several other forms of dynamometers; a large, electrically driven chronograph, built in the laboratory; a 36-foot open mercury column; special apparatus for testing pressure and vacuum-gauges and indicator springs; gauges; indicators; thermometers; pyrometers; tachometers; standard weights; steam pumps and injectors; rotary and centrifugal pumps; water meters; water motors, including a special universal water motor, built in the laboratory, together with pressure tanks and pumps for testing motors; hydraulic rams; water-wheels; air pumps; blowers; apparatus for making tests on radiators and pipe coverings; apparatus for furnace gas analysis; a street railway motor; and other apparatus having special reference to work of investigation.

The *Iron Room*, or machine shop, and the *Wood Room*, or pattern shop, each 40 by 80 feet, contain the tools and apparatus usually found in first-class establishments, including special tools built in the laboratory. The pattern loft, 40 by 80 feet, contains a fine collection of patterns made in the laboratory.

The *Forge Shop*, 30 by 40 feet, is equipped with twelve forges, built in the laboratory. The blast is supplied by a No. 4 Sturtevant pressure blower, and the smoke is carried away by a No. 31 exhaust fan.

The *Foundry*, 30 by 40 feet, contains a 27-inch cupola, brass furnaces, and a core-oven; the blast is supplied by a No. 3 Sturtevant pressure blower.

The central wing, 32 by 54 feet, contains, on the first floor, a well-ventilated wash-room, with closets and other conveniences, an engine room with a 10 by 30 Reynolds-Corliss engine, and superintendent's office; on the second floor a well-lighted drawing room and a blue-print room. The basement and attic are used for storage. The tower, at an elevation of 75 feet, contains a tank of 100 barrels capacity for experimental work in hydraulics; also a mercury column and other apparatus.

New machinery is added to each shop from time to time for the accommodation of engineering students and others desiring instruction and practice in the use of tools for working in wood and metal. At the same time opportunity is afforded them to become familiar with the more common materials and forms of construction used in engineering structures, buildings, and machinery. In all work an effort is made to follow the practice of the best shops.

The instruction in all practical work is given by men of wide experience, selected for their mechanical skill.

THE ASTRONOMICAL OBSERVATORY.

The Observatory consists of a main part, with a movable dome, and two wings. The refracting telescope, mounted in the dome, has an object glass thirteen inches in diameter. The meridian circle is in the east wing, the observatory library in the west wing, and astronomical clocks are in the main part. Apparatus is also provided for meteorological observations.

A small observatory near the main building is used in the work of instruction and a certain amount of practice in determination of time, latitude and longitude is required of all civil engineering students. The small building contains an equatorial telescope of six inches aperture and a transit instrument of three inches aperture, with zenith telescope attachment.

THE LIBRARIES.

The various libraries of the University contain about 98,700 volumes, and include a number of important special collections. The portion devoted to engineering contains the standard works in this department of science, and has files of important society proceedings and professional periodicals. The general reading room seats two hundred and ten readers, and additional rooms are provided for advanced students to work in, with the necessary books close at hand. Under certain restrictions graduate students have access to the book rooms. The library takes about four hundred and fifty periodicals, and is open, in term time, fourteen hours daily, except on Sundays and legal holidays, and six hours daily during the three months of the summer vacation.

THE ENGINEERING SOCIETY.

Several organizations of students are maintained, aside from the usual literary societies, for the reading of papers and holding discussions in various scientific lines. The Engineering Society, composed of and officered by students of this department, holds weekly meetings, at which papers of technical interest are read, and reports made upon observation and experiments. A reading room is maintained by the Society, accessible to all students of the department. Several engineers of prominence have spoken before the Society the past year. An annual, called the Technic, containing papers read before the Society, abstracts of theses, contributed articles from alumni, and other matters of professional interest, is published by the students.

THE SUMMER SCHOOL.

The Summer School, in session from June 29 to August 7, 1896, affords opportunity for study in languages, history, mathematics, natural, physical and applied science, and for work in the drawing rooms and laboratories A special Announcement can be had by addressing Mr. James H. Wade, Steward of the University.

THE WATERMAN GYMNASIUM.

The University is provided with an excellent gymnasium. The main floor, 150 by 90 feet, is well supplied with the various kinds of apparatus usually found in the best modern gymnasiums. A number of smaller rooms are devoted to administration, fencing and boxing, while the basement is occupied by baths and lockers. The main hall is lighted in the evening by electricity. A gallery makes room for an elliptical running track 375 feet in length. The facilities of the building, including physical examinations and instruction, are free to all students, the only charge being a rental of $2 a year for a locker. The aim has not been the development of a few gymnastic experts, but the provision of wholesome physical exercise for the many. The work thus far has been voluntary.

An athletic field of ten acres has been set apart and equipped for open air sports. Room is also provided for tennis courts. Foot-ball and base-ball are practiced by class and University teams.

THE LABORATORIES.

For a full account of all the laboratories and their various resources, as also of the University collections for the study of art, archæology, ethnology, mineralogy, paleontology, systematic zoology, etc., consult the annual Calendar, which may be had gratis on application to Mr. James H. Wade, Steward of the University. Those laboratories closely connected with the Department of Engineering are described on p. 17 to 20.

UNIVERSITY ORGANIZATIONS.

An attractive series of lectures and musical entertainments is provided each year at a low price by the Students' Lecture Association. The Choral Union is an organization of students and others for the study and practice of choral music. A course of concerts and a festival of three days in May are announced under its auspices each year.

The Oratorical Association fosters an interest in oratory and its members have been remarkably successful in recent contests.

COURSES OF INSTRUCTION.

The Courses of Instruction are subject to change from time to time; those announced for the year 1895–96 and required for graduation, as stated on pages 31 to 33, are described below, together with some technical elective courses which are designated accordingly. The amount of credit towards graduation assigned to each course is indicated by the expressions *one hour*, *two hours*, etc., an *hour of credit* being given for the satisfactory completion of the work equivalent to one exercise a week during one semester. Lectures and recitations are usually one hour in length; but in laboratory work, drawing, and other practical exercises, a longer attendance is required in order to secure an hour of credit.

The courses given in the Department of Literature, Science, and the Arts, are (with the exception of the courses in French and in German, for which special permission is required) all open as electives to engineering students who are qualified to pursue them with advantage.

FRENCH.

FIRST SEMESTER.

B. Narrative Prose. Two sections. *Two hours.*

Course B is open to those who have taken Course A, or who have passed an entrance examination in French.

D. Scientific Reading. *Two hours.* Mr. FRANCOIS.

SECOND SEMESTER.

A. Beginner's Course. Grammar and Reader. Two sections. *Four hours.* Mr. FRANCOIS.

C. Descriptive Prose. *Two hours.*

GERMAN.

FIRST SEMESTER.

A. Beginner's Course. Thomas's German Grammar, Part 1, and an easy German Text. Two sections. *Four hours.* Mr. DIEKHOFF.

C. Descriptive Prose. *Two hours.* Mr. DIEKHOFF.

SECOND SEMESTER.

B. Narrative Prose. Easy Stories. Two Sections. *Two hours.* Mr. DIEKHOFF.

D. Technical Prose. Dippold's Science Reader. Two sections. *Two hours.* Mr. DIEKHOFF.

ENGLISH AND RHETORIC.

FIRST SEMESTER.

1. Paragraph-Writing. *Two hours.* Mr. STRAUSS.

SECOND SEMESTER.

1. Paragraph-Writing. Three sections. *Two hours.* Mr. STRAUSS.

MATHEMATICS.

Students of engineering are required to take in order Courses 1, 2, 3, 4, and 6. They are also required to take Course 1*b*, unless they have passed a satisfactory examination for admission in plane trigonometry, but no credit toward graduation is given to engineering students for Course 1*b*.

FIRST SEMESTER.

1. Algebra and Analytic Geometry (1). Five sections. *Four hours.* Mr. LYMAN, Mr. HALL, Mr. GODDARD, and Mr. COAR.

1*b*. Plane Trigonometry. Three sections. *Two hours.* Mr. GODDARD and Mr. COAR.

3. Calculus. Four sections. *Five hours.* Professor ZIWET, Mr. LYMAN, and Dr. GLOVER.

6. Calculus and Mechanics (II). Three sections. *Four hours.* Professor ZIWET and Mr. LYMAN.

SECOND SEMESTER.

2. Analytic Geometry (II). Six sections. *Four hours.* Mr. LYMAN, Mr. HALL, Mr. GODDARD, and Mr. COAR.

4. Calculus and Mechanics (I). Three sections. *Five hours.* Professor ZIWET, Mr. LYMAN, and Dr. GLOVER.

PHYSICS.

FIRST SEMESTER.

1. Mechanics, Sound, and Light. *Five hours.* Dr. ST. JOHN.

Course 1 is open to those who have passed an entrance examination in physics, and to all others who have sufficient preparation. A knowledge of plane trigonometry is indispensable.

3. Physical Laboratory Work for Beginners. This course may be elected as 3*a*, *three hours*; or 3*b*, *two hours.* Dr. GUTHE. Fee, $3.00 or $2.00.

Course 3 must be preceded or accompanied by Course 1. It is also given in the second semester. Students presenting note-books from High School physical laboratories approved by this department may be allowed three hours credit instead of two for Course 3*b*.

7. Electricity and Magnetism; Mascart and Joubert. *Three hours.* Assistant Professor PATTERSON. (Elective.)

Course 7 must be preceded by Course 2. A knowledge of calculus is also required.

16. Theory of Heat: Preston. *Two hours.* Professor CARHART. (Elective.)

SECOND SEMESTER.

1. Mechanics, Sound and Light. *Five hours.* Dr. ST. JOHN.

See note to Course 1, first semester.

2. Electricity and Magnetism. *Four hours.* Professor CARHART and Dr. ST. JOHN.

Course 2 must be preceded by Course 1 and by a course in general or in analytical chemistry.

2*a*. Heat. Lectures and recitations. *Two hours.* Professor CARHART and Dr. ST. JOHN.

Course 2*a* must be preceded by Course 1.

3. Physical Laboratory Work for Beginners. Assistant Professor PATTERSON and Dr. GUTHE. Fee, $3.00.

See note to Course 3 in the first semester.

10. Electricity and Magnetism: Mascart and Joubert. *Two hours.* Assistant Professor PATTERSON. (Elective.)

Course 10 must be preceded by Course 7.

12. Advanced Laboratory Work in Electricity and Magnetism. *Three hours.* Dr. GUTHE. Fee, $3.00. (Elective.)

Course 12 must be preceded by Course 2, Electrical Engineering.

15. Photometry. Continuation of Course 14, Electrical Engineering. Laboratory work. *One or two hours.* Assistant Professor PATTERSON. Fee, $1.00 or $2.00. (Elective.)

18. Theory of Potential and its Applications. *Two hours.* Dr. GUTHE. (Elective.)

Course 18 must be preceded by Course 2. A knowledge of calculus is required.

19. Design of Electrical Machinery and Appliances. Lectures. *Two hours.* Professor CARHART. (Elective.)

Course 19 must be preceded by Course 8*a*, Electrical Engineering.

CHEMISTRY.

The laboratory work requires from two to three hours daily, taken between 1 and 6. Permission for forenoon hours is given when necessary.

FIRST SEMESTER.

1. Elementary Inorganic Chemistry, Descriptive and Experimental. Lectures and recitations. *Three hours.* Mr. HIGLEY.

Course 1 is not open to students credited with chemistry for admission. Such students must elect either Course 2 or Course 3.

EITHER FIRST OR SECOND SEMESTER.

2. Laboratory Work in General Chemistry. *Three hours.* Mr. HIGLEY and Mr. LICHTY.

Course 2 must be preceded or accompanied by Course 1 or an equivalent. It is supplementary to Course 1 and covers in the laboratory the ground covered by lectures in Course 1.

SECOND SEMESTER.

3. First Steps in Qualitative Analysis. Recitations and laboratory work. *Five hours.* Professor JOHNSON.

Course 3 is a short course, designed for students of civil, mechanical, and electrical engineering.

METALLURGY.

FIRST SEMESTER.

2. Micro-Metallography. The study of the microscopic structure of metals as related to their physical and chemical properties. Laboratory work with reading. *One hour.* Professor E. D. CAMPBELL. (Elective.)

Course 2 can be taken only by those who have taken Course 1, and have received special permission.

SECOND SEMESTER.

1. Fuel and Refractory Material, Iron and Steel. *Three hours.* Professor E. D. CAMPBELL.

Course 1 must be preceded by Course 1 or Course 3 in chemistry, or an equivalent.

ASTRONOMY.

EITHER FIRST OR SECOND SEMESTER.

4. Practical Astronomy. Use of portable transit. *Three hours.* Mr. GILLIS.

Course 4 requires a knowledge of logarithms, spherical trigonometry, and differential and integral calculus.

SECOND SEMESTER.

5*a*. Computing. *Two hours.* Mr. GILLIS. (Elective.)

MINERALOGY.

EITHER FIRST OR SECOND SEMESTER.

1. Lectures and practice. *Two hours.* Professor PETTEE.

For Course 1 an elementary knowledge of chemistry is desirable.

DRAWING.

FIRST SEMESTER.

1. Elementary Drawing. Practice. Three sections. *Two hours.* Mr. WRENTMORE and Mr. GOULDING.

Sec. I is for students of civil engineering, Sec. II for students of electrical engineering, and Sec. III, which begins the seventh week of the semester, is intended for students of mechanical engineering, who take Course 4 in surveying in the first six weeks of the semester.

4. Free-hand Drawing; Pen and Ink Drawing; Sketching. *Three hours.* Professor DENISON or Miss HUNT.

9. Sketching of Parts of Machines; Lettering. *Three hours.* Professor DENISON.

Course 9 is designed especially for students of mechanical engineering.

10. Continuation of Course 8. *Two hours.* Professor DENISON or Miss HUNT. (Elective.)

Course 10 must be preceded by Courses 4 and 8. The section is limited in number.

13. Water-Color Drawing. *Three hours.* Professor DENISON or Miss HUNT.

Course 13 must be preceded by Course 8. It can be taken only by special permission.

SECOND SEMESTER.

5. Descriptive Geometry. Recitations and drawing. Five sections. *Three hours.* Professor DENISON, Mr. WRENTMORE, and Mr. GOULDING.

Course 5 must be preceded by Course 1. Sec. I is for students of civil engineering, Sec. II for students of electrical engineering, Sec. III for students of mechanical engineering, Secs. IV and V for others.

6. Shades, Shadows, and Perspective. *Three hours.* Professor DENISON.

Course 6 must be preceded by Course 5.

7. Free-Hand Drawing (advanced). *Three hours.* Professor DENISON or Miss HUNT. (Elective.)

In Course 7 the section is limited in number.

8. Architectural and Water-Color Drawing. *Two hours.* Professor DENISON or Miss HUNT. (Elective.)

Course 8 must be preceded by Course 1 or 4. The section is limited in number.

14. Stereotomy. *Two hours.* Professor DENISON.

Course 14 must be preceded by Course 5.

SHOP PRACTICE.

EITHER FIRST OR SECOND SEMESTER.

All courses in shopwork are under the supervision of Superintendent C. G. TAYLOR, who gives in each of the Courses, *1a*, *2a*, *3a*, and *4a*, lectures on workshop appliances and materials. Fee for each course in shop-work, $5.00.

Courses *1a*, *2a*, *3a*, *4a*, below and *6a*, Mechanical Engineering, may also be elected by advanced students as *1b*, *2b*, *3b*, *4b*, and *6b*.

1*a*. Shop Practice. Wood work and pattern work. Three sections. *Three hours.* Mr. PURFIELD.

2*a*. Shop Practice in Forging. Six sections. *Two hours.* Mr. ORR.

3*a*. Shop Practice in Iron Work. Three sections. *Three hours.* Mr. SMOOTS.

4*a*. Shop Practice in Foundry Work. Three sections. *Two hours.* Mr. WINSLOW.

SURVEYING.

1. Lectures and Field Practice with Instruments. *Four hours.* Professor J. B. DAVIS.

The field practice in Course 1 continues during favorable weather until Christmas.

4. Use of Instruments. *One hour.* Professor J. B. DAVIS.

Course 4 covers the first six weeks of the semester, and is for students of mechanical engineering who take Course 1 in drawing the remainder of the semester.

6. Continuation of Course 5. Photo-topography. Field work and drawing. *One hour.* Professor J. B. DAVIS.

The ability to make photographic negatives will be of service.

SECOND SEMESTER.

2. Continuation of Course 1. Lectures and text-book. *Five hours.* Professor J. B. DAVIS.

Course 2 must be preceded by Course 1.

3. Field Work in Camp for four weeks. Professor J. B. DAVIS.

Except by special permission Course 3 is open only to students who are working for a degree in civil engineering. It is given in June.

5. Topography. Transit and Stadia. Plane Table. Field work and drawing. *Three hours.* Professor J. B. DAVIS.

Course 5 is given four times a week for thirteen weeks.

7. Geodesy. Geodetic Methods. Lectures and text-book. *Three hours.* Professor J. B. DAVIS. (Elective.)

Course 7 must be preceded by Courses 1 and 2. It is given five times a week for twelve weeks.

CIVIL ENGINEERING.

FIRST SEMESTER.

1. Municipal Engineering. Lectures and text-book. *Five hours.* Professor J. B. DAVIS. (Elective.)

4. Graphical Analysis of Structures. *Two hours.* Professor GREENE.

Course 4 must be preceded by Course 3.

5. Strength and Resistance of Materials. Two sections. *Two hours.* Professor GREENE.

Course 5 must be preceded by Course 6 in mathematics. Sec. I is for students in civil engineering; Sec. II, for others.

6. Engineering. Theory of construction. *One hour.* Professor GREENE.

Course 6 must be preceded by Course 6 in mathematics.

7. Engineering Design. *Five hours.* Professor GREENE.

Course 7 accompanies Courses 5 and 6.

SECOND SEMESTER.

2. Tests of Materials. *One hour.* Professor GREENE. (Elective).

3. Graphical Analysis of Structures. Two sections. *Two hours.* Professor GREENE.

Course 3 requires at least a limited knowledge of statics. Sec. II is for students in civil engineering; Sec. I, for others.

8. Engineering. Theory of construction. *Four hours.* Professor GREENE.

9. Hydraulics. Two sections: *One hour.* Professor GREENE.

10. Water Supply and Sewerage, *One hour.* Professor GREENE. (Elective.)

MECHANICAL ENGINEERING.

FIRST SEMESTER.

5*a*. Principles of Mechanism. *Three hours.* Professor DENISON.

5*b*. Principles of Mechanism. *Two hours.* Professor DENISON.

Course 5*a* is for students of mechanical and of electrical engineering; Course 5*b* is for students of civil engineering. Both courses must be preceded by Course 1 in mathematics, and by Courses 1 and 5 in drawing.

8*a*. Prime Movers. Water wheels and steam engines. *Two hours.* Professor COOLEY and Assistant Professor WAGNER.

8*b*. Prime Movers. Water wheels. *One hour.* Professor COOLEY.

Course 8*b* is intended for those who have taken Course 9; 8*a*, for all others. Both courses must be preceded by Course 7*a* or 7*b*.

10. Theory of Machine Design, including Electrical Design. *Two hours.* Professor COOLEY and Assistant Professor WAGNER.

Course 10 must be preceded or accompanied by Course 5 in civil engineering.

11. Design of General Machinery. *Three hours.* Professor COOLEY.

Course 11 should be accompanied by Course 10.

12. Thermodynamics. Hot-air and gas engines, air compressors, and refrigerating machines. *Two hours.* Assistant Professor WAGNER.

Course 12 must be preceded by Course 7 and by Courses 1 and 2 in physics.

EITHER FIRST OR SECOND SEMESTER.

6*a*. Design of Shop Machinery. One or two sections. *Two hours.* Superintendent C. G. TAYLOR.

Course 6*a* must be preceded or accompanied by Course 5*a* or 5*b*, and be preceded by Courses 1, 5, and 9, in drawing.

16. Steam Engineering. Practical work in the laboratory. *Three hours.* Professor COOLEY and Assistant Professor WAGNER. Fee, $5.00.

Course 16 must be preceded or accompanied by Course 8*a* or 8*b*.

SECOND SEMESTER.

7*a*. Dynamics of Machinery. Two sections. *Two hours.* Assistant Professor WAGNER.

7*b*. Dynamics of Machinery. *One hour.* Assistant Professor WAGNER.

Course 7*b* is the same as the first half of Course 7*a*, and is intended for students of civil engineering. Both courses must be preceded by Course 6 in mathematics, and by Course 1 in physics.

9. Steam Engines. Valve gears. *Three hours.* Assistant Professor WAGNER.

Course 9 must be preceded or accompanied by Course 7*a* or 7*b*.

13. Machinery and Mill Work. *Two hours.* Professor COOLEY.

14. Design of Engines and Boilers. *Two hours.* Professor COOLEY.

ELECTRICAL ENGINEERING.

FIRST SEMESTER.

4. Primary and Secondary Batteries. Recitations and laboratory work. *Two hours.* Dr. GUTHE. Fee, $1.00.

Course 4 must be preceded by Courses 1, 2, 3, in physics and a course in general or in analytical chemistry.

5. Electrical Measurements. Lectures, recitations, and laboratory work. *Four hours.* Professor CARHART, Assistant Professor PATTERSON, and Dr. GUTHE.

Course 5 must be preceded by Courses 1, 2, and 3, in physics. A knowledge of calculus is also required.

9. Distribution of Electricity. Lectures. *Two hours.* Assistant Professor PATTERSON.

Course 9 must be preceded by Course 8*a*.

13. The Alternate Current Apparatus. *Two hours.* Professor CARHART.

Course 13 must be preceded by Course 8*a*.

14. Photometry of Electric Lamps: Palaz. Recitations and laboratory work. *Two hours.* Assistant Professor PATTERSON. Fee, $1.00.

SECOND SEMESTER.

8*a*. Electro-Dynamic Machinery. Lectures and laboratory work. *Four hours.* Professor CARHART and Assistant Professor PATTERSON. Fee, $3.00.

Course 8*a* must be preceded by Course 5 and is for students of electrical engineering only.

See also physics for elective work.

MARINE ENGINEERING.

Course 2 is designed for graduate students and undergraduates who have had the necessary preliminary training. Courses 1 and 3 are for graduates.

FIRST SEMESTER.

1. Naval Architecture. Professor COOLEY.

SECOND SEMESTER.

2. Marine Engines. *Three hours.* Professor COOLEY. (Elective.)
3. Ship-Building. Professor COOLEY.

MINING ENGINEERING.

SECOND SEMESTER.

1. Exploitation of Mines. Methods of opening, laying-out, and working mines. *Five hours.* Professor PETTEE. (Elective.)

Course 1 requires a knowledge of mineralogy and general geology.

REQUIREMENTS FOR GRADUATION.

THE DEGREE OF BACHELOR OF SCIENCE.

To earn the degree of Bachelor of Science in civil, mechanical, or electrical engineering, the student must secure *one hundred and twenty Hours of Credit** in a prescribed course of study, as given below, and must present a satisfactory thesis. The diploma given indicates the line of study pursued.

Bachelors of Arts, of Philosophy, of Science, and of Letters, of this University, and graduates of any other reputable college, are recommended for the same degree with the regular students, after completion of the special requirements alone of the several courses. These requirements can be completed in two years. The culture imparted by classical or other liberal training will be found to have its uses for one engaged in engineering work, and previous discipline of the faculties in exact research will enable the professional student to master more easily the requirements of the course. All the time the student can devote to general studies before taking up specialties will be well spent.

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*For explanation of the term Hour of Credit, see page 22; and for further information in regard to the courses prescribed for graduation, see pages 32 to 33

GENERAL REQUIREMENTS.

The *general requirements* are as follows:

In French and German; fifteen hours, to be selected by the student from all the courses open to him in these two languages.
In English: Course 1.
In Mathematics: Course 1, 2, 3, 4, 6.
In Physics: Course 1.
In Chemistry: Course 1 or Course 3.
In Drawing: Courses 1, 5.
In Civil Engineering: Course 5.

SPECIAL REQUIREMENTS.

The *special requirements* in the several courses are as follows:

1. *In Civil Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Civil Engineering, the student must satisfactorily complete, in addition to the thesis and the *general requirements* named above, courses as follows:

In Mineralogy: Course 1.
In Astronomy: Course 4.
In Drawing: Courses 4, 6, 14.
In Surveying: Courses 1, 2, 3, 5, 6.
In Civil Engineering: Courses 3, 4, 6, 7, 8, 9.
In Mechanical Engineering: Courses 5*b*, 7*b*, 8*a*.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and twenty Hours of Credit.*

2. *In Mechanical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Mechanical Engineering, the student must satisfactorily complete, in addition to the thesis and the *general requirements* named above, courses as follows:

In Physics: Courses 2, 2*a*.

In Drawing: Course 9.

In Surveying: Course 4.

In Civil Engineering: Courses 3, 9.

In Shop Practice: Courses 1*a*, 2*a*, 3*a*, 4*a*.

In Mechanical Engineering: Courses 5*a*, 6*a*, 7*a*, 8*b*, 9, 10, 11, 12, 13, 14, 16.

In Metallurgy: Course 1.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and twenty Hours of Credit.*

3. *In Electrical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Electrical Engineering, the student must satisfactorily complete, in addition to the thesis and the *general requirements* named above, courses as follows:

In Physics: Courses 2, 2*a*, 3*a*.

In Drawing: Course 9.

In Shop Practice: Courses 1*a*, 2*a*, 3*a*, 4*a*.

In Mechanical Engineering: Courses 5*a*, 6*a*, 7*a*, 8*a*.

In Electrical Engineering: Courses 4, 5, 8*a*, 9, 13, 14.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and twenty Hours of Credit.*

THE DEGREE OF MASTER OF SCIENCE

A candidate for the degree of Master of Science in this Department must have previously received the engineering degree of B.S. from this University, or, if graduated elsewhere, must satisfy this Faculty that he possesses equivalent attainments.

He must choose a *major* subject, which shall occupy one-half of his time, from the work given in this Department, and two *minor* subjects, each to occupy one-fourth of his time, to be selected from any work open to engineering students; all of the work, however, shall be subject to the approval of this Faculty. Study and residence for not less than one year will be required.

If the candidate for the degree of Master of Science desires to have his major subject count towards the degree of C.E., M.E., or E.E., such major subject must be advanced work in the course in which he took his bachelor's degree.

THE DEGREES OF CIVIL ENGINEER, MECHANICAL ENGINEER, AND ELECTRICAL ENGINEER.

The conditions on which the degree of Civil Engineer, as a second degree, is conferred, are as follows:

The degree of Civil Engineer may be conferred upon Bachelors of Science of this University, who have taken the degree for a course in civil engineering, if they furnish satisfactory evidence that they have pursued further technical studies for at least one year, and, in addition, have been engaged in professional work, in positions of responsibility, for another year. The first of the above requirements may be satisfied by pursuing at the University, under the direction of the Faculty, a prescribed course of study for an amount of time, not necessarily consecutive, equivalent to a college year. If the candidate does not reside at the University, his course of study must be approved in advance by the professor of civil engineering, and he must prepare a satisfactory thesis on some engineering topic, to be presented, together with a detailed account of his professional work, one month, at least, before the date of the annual Commencement at which he expects to receive the degree.

The conditions on which the degrees of Mechanical Engineer, and Electrical Engineer, as second degrees, are conferred upon Bachelors of Science of this University who have taken the degree for a course in mechanical engineering, or in electrical engineering, are analogous in character and in amount to those given above for the degree of Civil Engineer.

FEES AND EXPENSES.*

Matriculation Fee.—For Michigan students, *ten dollars*; for all others, *twenty-five dollars.*

Annual Fee.—For Michigan students, *thirty-five dollars;* for all others, *forty-five dollars.*†

Diploma Fee.—The fee for the diploma given on graduation is ten dollars, and the by-laws of the Board of Regents prescribe that no person shall be recommended for a degree until he has paid all dues, including the fee for diploma.

Laboratory Courses.—The required laboratory courses cost approximately as follows: *Shop Practice.*—In the mechanical and electrical engineering courses, *twenty dollars. Physical Laboratory.*—A charge of *one dollar* is made for a course requiring one exercise a week during one semester, and at the same rate for the longer courses. *Mechanical Laboratory.*—The charge for the course in steam engineering is *five dollars. Chemical Laboratory.*—Students who take laboratory courses in chemistry are required to pay for the materials and apparatus consumed by them. The average expense is about *ten dollars.*

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*The Matriculation Fee and the Annual Fee must be paid in advance. No portion of the fees can be refunded, except by order of the Board of Regents, to students who leave the University during the academic year. A by-law of the Board of Regents provides that no student or graduate shall be allowed to enjoy the privileges of the University until he has paid all fees that are due.

†An annual fee of ten dollars is required of all graduates who are granted the privilege of pursuing studies for an advanced degree *in absentia.*

The fee required for any course has to be paid before the work of the course is begun.

The total amount of fees paid to the University during the whole four years' course, for matriculation, incidental expenses, materials used and diploma, is, for Michigan students, from $175 to $200; and for others, from $230 to $255, varying more or less according to the student's actual laboratory expenses.

Other Expenses.—Students obtain board and lodging in private families for from three to five dollars a week. Clubs are also formed in which the cost of board is from one dollar and a half to two dollars and a half a week. Room rent varies from seventy-five cents to two dollars a week for each student. The annual expenses of students, including clothing and incidentals, are, on the average, about three hundred and seventy dollars. The University does not undertake to furnish manual labor to students; yet a few find opportunities in the city for remunerative labor.

There are no dormitories and no commons connected with the University. Students on arriving in Ann Arbor can obtain information in regard to rooms and board by calling at the Steward's office.

Students are temporary residents of the city, and, like all other residents, are amenable to the laws. If guilty of disorder or crime, they are liable to arrest, fine, and imprisonment. A rule of the University Senate provides that if a student is arrested, or is convicted by the civil authorities, he shall be cited to appear before the Faculty of the department in which he is matriculated, and shall be liable to suspension or expulsion.

REQUIREMENTS FOR ADMISSION. 1898.

In 1898, and thereafter, the subjects in which applicants for admission to the Department of Engineering will be examined will be as follows:

English Language, as now specified, p. 6–7.

English Literature, as now specified, p. 7.

Mathematics, as now specified, p. 7–8.

Physics, as now specified, p. 8.

French or **German** or **Latin,** as now specified, p. 8–9.

History.—Myers' General History and one year's work in United States History and Civil Government. Johnston's History of the United States and Fiske's Civil Government or Hinsdale's American Government are recommended as text-books.

Chemistry.—One year's work. As a text-book, Freer's Elementary Chemistry, or an equivalent amount of work in Remsen's Introduction to the Study of Chemistry, is recommended. In either case the text should be accompanied by laboratory work.

Botany, Physical Geography and Astronomy.—The applicant may offer any *one* of these subjects. The requirement, intended to cover a half-year's work, is as follows:

Botany.—Practical exercises in the study of common plants, so conducted as to secure a familiar acquaintance with the essential facts of vegetable morphology, physiology, and relationship. The method pursued in Spalding's Introduction to Botany will indicate the kind of work desired.

Physical Geography.—Tarr's Elementary Physical Geography, especially chapters 9 to 21 inclusive, or an equivalent.

Astronomy.—Newcomb and Holden's Astronomy, Briefer Course, Young's Elements of Astronomy, or an equivalent. A knowledge of the principal constellations is required.

Students who have satisfied the requirements for admission to the Department of Literature, Science and the Arts will be admitted to the Department of Engineering upon completing the requirements in Chemistry and Plane Trigonometry.

Any applicant who can offer the above subjects previous to 1898 is encouraged to do so.

Department of Engineering.

REGISTER OF ALUMNI.

The degrees of C E. and M.E. were conferred as first degrees until 1882. Where no note follows the name, the degree was taken in civil engineering. Beginning with 1882, the degree was changed to B.S.

1860.

FRANK KRAUSE. Locating Eng., Iowa Midland R. R., '70–'71. With L. H. Everts & Co., Map Publishers, '71–'74. Asst. City Eng. Cleveland, '76. Locating Eng. N. Y. C. & St. L. R. R., '81–'82. City Eng. Galion, O., '80 and '83. Div. Eng. Big 4 R. R., '85–'90. Civil Eng. Cleveland, O.

WM. MINTO. U. S. Surveys, '71–'75. Chief Eng. Sierra Flume and Lumber Co., '75–'77. Asst. Surveyor S. F. Savings Union. Civil and Mining Eng. Orinda Park, Cal.

1861.

PETER S. GIBSON, M. S., '64. M. Can. Soc. C. E. Govt. Ont. Land Surveyor. Mem. Bd. of Exam. Govt. Land Surveyors. Eng. for Townships of York, North Toronto, East Toronto and other towns. Dom. Land Surveyor and Civ. Eng. Willowdale, Ont., Canada.

GEO. H. SEYMOUR, B.S., '60. Asst. Eng. U. P. R. R., '64–'67. Asst. City Eng. Council Bluffs, '67–'68. Asst. Eng. K. P. R. R., '69–'70. Do. M. K. & T. R. R., '70–'71. Do. N. P. R. R., '71–'73. D. L. & L. M. R. R., '73. Fruit grower. Grand Haven, Mich.

JOSEPH W. WOOD, M. S., '62. Farmer. Sumner, Wash.

1862.

ELMORE H. WELLS, M. D., (Bellevue) '67. A. M., (Lafayette) '69. Instructor Civ. Eng. Univ. of Mich., '64. Asst. Eng. N. I. R. R., '64–'65. President M. B. Water Co. Physician. Meshoppen, Pa.

*ORLANDO B. WHEELER, A.B., '62, A.M., M.S., '65, C.E., '79, M. Am. Soc. C.E. U. S. Asst. Astronomer, Transit of Venus, '74. Do. '82. U. S. Asst. Astronomer Total Solar Eclipse, '78. U. S. Asst. Eng. on Geodetic Triangulation. Died at St. Louis, Mo., June 3, '96.

1863.

IRA S. DUNNING. R. R. Eng., '63–'89. City Eng. Aurora, '89–'92. Civ. Eng. Aurora, Ill.

GEO. A. MARR, M.S., '67. M. Am. Soc. C.E. U. S. Asst. Eng. on Survey of N. & N. W. Lakes, '63–'77. Do. Mississippi River Surveys, '78–'88. Do. Missouri River Surveys, '88–'91. U. S. Asst. Eng. and Supt. Portage Lake Ship Canal. Houghton, Mich.

WM. MENDENHALL. U. S. Asst. Eng. Lake Survey, Astron. Corps. Prof. Eng. Earlham Coll. Mining Eng. Colo. Richmond, Ind.

WM. B. MORGAN, A.M. (Haverford) '58. Instr. Math. and Civ. Eng. U. of M., '64. Prof. of Math. and Eng. Purdue Univ., '74–'75. Prof. of Math. and Astron. Penna. Coll., '76–'83. Prof. of Math. and Astron. Earlham Coll. Richmond, Ind.

STILLMAN W. ROBINSON. M. Am. Soc. C.E. Do. Am. Soc. Mech. E. U. S. Asst. Eng. Lake Survey, '63–'66. Asst. Prof. Min. Eng. U. of M., '66–'70. Prof. Mech. Eng. Univ. of Ills., '70–'78. Do. Ohio State Univ., '78–'95. Engr. and Expert. Vice-Pres. Grip Machine Co. Mech. Eng. Wire Grip Fastening Co. Columbus, Ohio.

1864.

CHAS. F. BELLOWS, A.M., '67. Prof. of Math., Mich. State Normal, Ypsilanti, Mich., '67–'91. Principal Central Mich. Normal. Mt. Pleasant, Mich.

1865.

WM. BOUTON. City Eng. and Vice-Pres. Pitzman Co. of Surveyors and Engs. St. Louis, Mo.

WM. DONOVAN. U. S. Asst. Eng., Lake Survey, '65–'66. Asst. Eng. J. L. & S. R. R. '67–'70. Chief. Eng. do. '70–'75. Res. Eng. Gt. W. R. R. of Can., '75–'77. Mang. Dept. Taxes and Collections J. L. & S. R. R. Prest. State Savings Bank. Lansing, Mich.

ARTHUR HILL. R. R. Survey, '66. Lumberman. Saginaw, Mich.

DAVID MCKENZIE, B.S., (Rochester) '60. Locating, Res. and Chief Eng. on R. R.'s in Canada and U. S. Civ. Eng. Evansville, Ind.

ACHILLES W. UNTHANK, R. R. Locating Eng. in South America. Prof. in Emperor's Coll., Japan. Preliminary Survey R. R. in China. Civ. Eng. San Francisco, California.

GEO. Y. WISNER. M. Am. Soc. C.E. U. S. Asst. Eng. Lake Survey. Do. Geodetic Work Mississippi River. R. R. Location. Survey Ill. and Mich. Canal. Supt. Const'n 10th and 11th Lighthouse dists., '65–'88. Res. Eng. Miss. River Jetties, Port Eads, La. Sanitary Eng. Detroit Health Dept. Detroit, Mich.

1866.

***ABEL R. FLINT.** U. S. Asst. Eng. Lake Survey. Died at Detroit, May 31, '84.

LEWIS FOOTE. U. S. Asst. Eng. Lake Survey, '64–'74. Farmer. Worthington, Minn.

ARCHIBALD JOHNSON, M.S., '72. Eng. on R. R. Const'n, '66–'83. U. S. Asst. Eng. St. Paul, Minn.

HORACE W. LEWIS.

JOHN W. REMINGTON.

*CASSIUS M. C. SNOVER. Engr. C. & N. W. R. R., '66–'67. Chief Eng. Midland Pacific R. R. '69. Div. Eng. M. C. R. R., '71–'86. Died at Detroit, Feb. 18, '86.

ARTHUR P. WOOD. Asst. Eng. U. P. R. R., '68–'72. Supt. Const'n Tex. Pacific R. R. Colo. Div., '72–'75. Asst. Eng. Omaha & N. W. R. R., '75. Chief Eng. O. N. & B. H. R. R. R. R. Contractor. Omaha, Neb.

1867.

GEO. H. BENZENBERG. M. Am. Soc. C.E., M. Am. W. W. Assoc. U. S. Asst. Eng. Lake Survey and Locating and Const'n Eng. C. M. & St. P. and M. & N. R. R.'s, '68–'74. Do. M. & N. R. R., '74–'81. Consulting Eng. on Sewerage and Water Works. City Eng. and Pres't B'd Pub. Wks. Milwaukee, Wis.

AMOS E. DOLBEAR, (Mining) A.M., '67, Ph D., 83. A.B. (Ohio Wes.) '66. A.M., do. '69. Prof. Nat. Sc., Bethany Coll., '68–'74. Prof. Physics and Astronomy, Tufts Coll. since '74. Tufts College, Mass.

LOWELL A. GOODMAN, Horticulturist. Westport, Mo.

LEWIS P. JUDSON. U. S. Asst. Eng. Lake Survey and Canal Work, '67. Asst. Eng. C. R. I. & P. R. R., '68–'69 City Eng. Council Bluffs, '70–'82. Civ. Eng. and Surveyor. Council Bluffs, Ia.

WILLIAM B. RISING, (Mining) A.B. (Hamilton) '64. Ph.D., (Heidelberg). Prof. Chemistry, Univ. of California. Berkeley, Cal.

*JAMES STEEL, A B. (U. S. Naval Academy), '68. Eng. U. S. Navy, '68. Died at sea, Aug. '69.

ALEXANDER THOMSON. Mining Eng., '67–70. Asst. Prof. Mech. Eng. Ills. State Univ., '70–'71. Asst. Prof. Math. and Civ. Eng. Iowa Univ., '72–'73. Prof. Mech. Eng. Iowa Agrl. Coll., '73–'84. Vice-Pres't K. C. W. & G. R. R. and Chief Eng. N. Am. Land and Timber Co. Lake Charles, La.

EBENEZER S. WHEELER. M. Am. Soc. C.E. U. S. Asst. Eng. Lake Survey, '67–'82. Do. River and Harbor Imp., '82–'89. Do. in charge of St. Mary's Ship Canal. Sault Ste. Marie, Mich.

1868.

FRANCIS M. BAIN. Asst. Eng. C. & A. R. R. Transitman Bellaire and S. W. R. R. Ann Arbor, Mich.

Edward C. Burns, M. Am. Soc. C.E. Asst. and Chief Eng. R. R. Location and Const'n. U. S. Asst. Eng. Lime Kiln Crossing. Eng. in Charge of Sewers and Pavements. Jamestown, N. Y.

***Byron R. Chaffee**, (Mining). Died at Marcellus, N. Y., May 7, '70.

Brutus J. Clay. Manufacturer. Richmond, Ky.

Joseph B. Davis, Jun. Am. Soc. C.E. Asst. Prof. C.E., '72. Prof. of Geodesy and Surveying, Univ. of Mich. Ann Arbor.

Henry B. Durkee, (Mining). Mgr. Silver Smelting Wks. Stockton, Utah. Mining Eng. in Utah, Nev. and Cal. mines. Pres't Chicago Asbestos Mining and Mfg. Co. Director Drury Nickel Co. Do. St. Louis and Eastern R. R. and St. L. and C. R. R. Chicago, Ill.

***Tobert Entrekin**,(Mining). Died at Independence, Mo., Oct. 7, '77.

***Milo K. Havens**, Civ. Eng. Died at St. Louis, Mo., '85.

Edward S. Jenison, M.S., '72. Architect of Univ. Hall. Architect. Chicago, Ill.

Edgar S. Johnston, M.D., '79. Physician. Gibsonburgh, O.

Wm. S. MacHarg, (Mining). Eng. of Water Supply and Sewerage of Towns, '69–'79. Do. Buildings, '79–'90. Do. World's Columbian Exposition. Civ. Eng. Chicago, Ill.

Philetus H. Philbrick, M.S., '73. Asst. Eng. J. Ft. W. & C. R. R., '68–'69. Chief Eng. Owosso & N. W. R. R., '69–'72. Do. T. A. A. & N. M. R. R. Asst. Eng. Mich. Air Line. Prof. Civ. Eng. Iowa Univ., '73–'87. Eng. N. Am. Land and Timber Co. Lake Charles (Pineville) La.

Chas. Poore. Civ. Engineer. Western Springs, Ill.

Rollin J. Reeves. U. S. Surveyor Govt. Lands and Boundaries in Dak., Wyo., Oregon, Cal., New Mexico, Minn., Idaho, Colo. and Montana. Vice-Pres't Columbia Milling Co., '94–'95. Commissioner U. S. Circuit Court, Dist. of Washington. Wilber, Washington.

Fillmore M. Smith, (Mining). Mining Eng. and Chemist. Syracuse, N. Y.

Milford N. Wells. Asst. Eng. Ft. W. J. & S. R. R. and Mich. Air Line, '68–'71. Do. J. L & S. R. R., '71–'74. Chief Eng. T. A. A. & N. M. R. R., '74–'79. Res. Eng. A. T. & S. F. R. R. Chanute, Kan.

1869.

Hugh B. Alexander. Asst. Eng. San. Dist. of Chicago. Geneva, Ill.

Wm. H. Boardman, A.B., '68. Editor and Publisher. Pres't of the *Railroad Gazette Co.* New York, N. Y.

CHAS. F. BRUSH, (Mining). Ph.D. (Western Reserve) '80. (Cross of the Legion of Honor by French Government, 1881). M. Am. Soc. Mech. E., do. Am. Inst. E.E. Anal. Chemist and Expert '69–'73. Electrical Eng. and Inventor. Inventor of Brush Electric Light Apparatus. Capitalist. Cleveland, Ohio.

ORSON O. FOX. Tradesman. Pleasant Prairie, Wis.

CHAS. H. HAMILTON, (Mining). Wis. Legislature, '78 Milwaukee Sch. Bd., '89–'91. Do. Common Council, '92–'94. City Atty., '94 to date. Att'y at Law. Milwaukee, Wis.

JAMES C. HOLLIDAY, (Mining). Eng. Milwaukee Iron Mfg. Co., '70–'72. Real Estate, Minneapolis. Mining Eng. Chicago, Ill.

*GEORGE B. LAKE. Asst. Eng. A. T. & S. F. R. R., '71. Div. Supt. Do. '76. Supt. Track and Bridges, do. '78. Chief Eng. do. '84. Died at Topeka, Kan., Apr. 27, 1884.

DANIEL H. RHODES. Div. Eng. on Mich. R. R's., '69–'72. Do. C. & A. R. R. and B. & S. W. R. R., '72–'78. Asst. Eng., Res. Eng. and Supt. A. T. & S. F. R. R., '79–'85. Chief Eng. K. P. & W. R. R. and W. & W. R. R., '85–'89. Civ. Eng. Wichita, Kas.

ALBERT A. ROBINSON, M.S., '72, M. Am. Soc. C.E. Asst. Eng. St. Joe & D. C. R. R., '69–'71. Do. A. T. & S. F. R. R., '71–'75. Chief Eng. do. '75–'88. Supt. New Mexico Div., '80. Asst. Gen. Supt. and Gen. Supt., '82. Chief Eng., '83. Second Vice-Pres't and Chief Eng., '89–'93. Pres't Mex. Cen. R. R. Boston, Mass.

*THOMAS J. SEELEY. M. Am. Soc. C.E. Chief Eng. Chicago & Millington R. R., '69–'76. Asst. Eng. A. T. & S. F. R. R., '77–'83. Died in Kas., Oct. 2, '83.

LUCIAN SWIFT, (Mining). Eng. N. P. R. R., '71–'76. Mang. Minneapolis Journal. Minneapolis, Minn.

ELIJAH TREADWELL. Asst. Eng. F. & P. M. R. R., '70–'81. Res. Eng. A. T. & S. F. R. R., '81–'89. Chief Eng. Cin. Sag. & M. R. R., '89–'90. Asst. Eng. F. & P. M. R. R. East Saginaw, Mich.

*JOHN WHITING. U. S. Lake Survey, '69–'70. Died at St. Clair, Mich., Aug. 2, '70.

BENEZETTE WILLIAMS. Asst. City Eng. Chicago, '72–'78. City Eng. do., '79. Chief Eng. Sanitary Dist. of Chicago. Civ Eng. and Contractor. Chicago, Ill.

1870.

*JUDSON S. BIRD. Eng. and Contractor. Died in Kan., March 19, '82.

CLARENCE M. BOSS, (Mining). Mich. State Geol. Survey, '70–'71. Eng. in Charge of Const'n, H. & O. R. R. and C. & N. W. R. R., '71–'75. Mining Eng. and Surveyor for Marquette and Gogebic Mining Co.'s. Inspector of Gogebic Co.'s mines. Bessemer, Mich.

JOHN L. CULLEY. U. S. Inspector Sandusky Harbor, '70. Asst. Eng. Ashtabula, Youngstown and Pittsburgh R. R., '71-'72. Asst. City Eng. Cleveland, O., '73-'78. Civil Engineer. Cleveland, O.

HARLOW P. DAVOCK, M.S., '73. Asst. Eng. St. L. & S. E. R. R., C. & V. R. R., Erie R. R., Cin. So. R. R., '70-'74. U. S. Asst. Eng. St. Marys Falls Canal, '75-'81. Do. Cascade Locks, '81-'82. Att'y at Law. Detroit, Mich.

LUTHER E. FERGUSON. U. S. Lake Survey, '74. Farmer. White Pigeon, Mich.

CHAS. P. GILBERT. R. R. Eng. in Mo., Ill. and Ind., '70-'71. U. S. Asst. Eng. St. Marys Falls Canal, '71-'74. Do. Sand Beach Harbor of Refuge, '74-'88. Mgr. of Edison Illum. Co., Detroit. Do. Central Station Elec. Lighting and Power Co. Berkeley, Cal.

*JAMES A. HAYWARD. U. S. Harbor Survey, '73. U. S. Asst. Eng. Galveston Harbor. Drowned near Texas Coast, Aug. 12, '80.

CHAS. J. KINTNER. U. S. Asst. Eng. and Astronomer, Wheeler Geog. Survey, '77-'78. Chief Clerk U. S. Patent Office in Charge of Electrical Div., '82-'87. Elect. Expert and Pat. Atty. New York, N. Y.

MICHAEL A. MEYENDORFF. Eng. in Charge of Big Wabash Bridge. Do. No. Pac. R. R., '72. Deputy U. S. Min. Surveyor, Arizona, '73-'74. Do. Montana, '74. Supt. Const'n U. S. Assay Office, Helena, Mon., '75. Melter U. S. Assay Office, '76-'88. Lecturer. New York, N. Y.

GEO. W. MICKLE. U. S. Lake Survey, '70-'71. Asst. to Prof. Watson. Preparing Lunar Tables, '71-'73. Contractor, '73-'80. Dealer in Agrl. Implements and Machinery. Leavenworth, Kas.

ALFRED NOBLE, M. Am. Soc. C.E. U. S. Asst. Eng. St. Marys Falls Canal and River Imp., '70-'82. Eng. in Charge of Shreveport Bridge, '82-'83. Do. Snake River Bridge, Clark's Fork of Columbia River Bridge. Cairo and Memphis Bridges. Asst. Chief Eng. Bellefontaine, Alton and Leavenworth Bridges. Gen. Asst. Eng. N. P. R. R. Mem. Nicaragua Canal Commission. Civ. Engineer. Chicago, Ill.

HENRY C. RIPLEY. U. S. Asst. Eng. River and Harbor Imp. Great Lakes and Gulf of Mexico, '70-'90. Civ. and Hydrographic Engineer. Galveston, Tex.

WM. J. WATERS, (Mining).

WARREN C. WILLITS. Deputy U. S. Min'l and Land Surveyor. Examining Clerk in U. S. Sur. Gen's Office for Colo. Denver, Colo.

1871.

ALBERT E. BALDWIN.

ALLEN P. BOYER. Manufacturer. Goshen, Ind.

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*JAMES D. BURR. M, Am. Soc. C.E. Locating Eng. on A. T. & S. F. R. R., '72–'73. Res. Eng. C. & S. R. R., '75–'77. Asst. Eng. A. T. & S. F. R. R., '77–'86. Died at Topeka, Kan., May 4, '86.

JOHN EISENMANN. U. S. Asst. Eng. Lake Survey and Miss. Riv. Com., '71–82. Prof. Eng. and Drawing, Case Sch. of Applied Science, '82–'86. Consulting Architect Cleveland Board of Education. Do. City Hall Commission. Arch't Ohio Masonic Home and other structures. Mem. Ohio State House Commission. Architect and Engineer. Cleveland, O.

JOHN A. FULTON, M. Am. Soc. C.E. Locating and Const. Eng. Cin. So. R. R., '73–'75. Div. Eng. A. T. & S. F. R. R., '76–'80, '82 and '88. Do. A. & P. R. R., '81. Eng. Smith Bridge Co., '83–'85. Asst. Eng. C. S. F. & Cal. R. R., '86–'87. Res. Eng. T. St. L. & K. C. R. R., '88. Civ. Engineer. LaGrange, Ill.

JOSIAH L. LITTLEFIELD. Co. Surveyor and Civ. Eng., '71–'73. Lumberman and Manufacturer. Farwell, Mich.

*LYMAN MASON, B.S., (Mich. Agl.) '69, M.S. do. '71. Asst. Eng. J. L. & S. R. R., '71–'72. Civ. Engineer. Died at Gaylord, Mich., July 16, '81.

ADRIAN J. PARSHALL. Chief Clerk State Bd. Land Com'rs. Cheyenne, Wyoming.

*BARON H. PENNINGTON. Surveyor and Farmer. Died at Macon, Mich., Feb. 17, '96.

ELLIOTT D. PERRY. Salt Lake City, Utah.

CHAS. PRATT, A.M. (Madison) '76. M.D. (Jefferson Med. Coll.) '81. U. S. Asst. Eng. Lake Survey, '72–'78. Do. River and Harbor Imp. on St. Marys Ship Canal, '78–'81. Physician. Los Angeles, Cal.

HENRY G. PROUT, M. Am. Soc. C.E. In Charge of Survey Riverside Imp. Co., Cook Co., Ill., '71. Topographer U. S. Expedition, Yellowstone Park. Eng. Painesville and Youngston R. R. Do. Saddle Riv. R. R., '72. Major of Eng'rs and Col. of Staff, Egyptian Army. Governor Equatorial Provinces, '74–'78. Editor in Chief *Railroad Gazette*. New York, N. Y.

ALEXANDER B. RAYMOND. Eng. Chicago & Mich. Lake Shore R. R., '71. Do. M. C. R. R., '72–'73. Do. N. Y. C. R. R., '73–'75. Asst. City Eng. Detroit, '76–'77. Merchant. Detroit, Mich.

*CURTIS C. SMITH. Died at Pomeroy, O., Sept. 15, 1872.

SAMUEL W. WALKER. Lumber Merchant. Munich, Mich.

J. BURKITT WEBB. Asst. Prof. Civ. Eng. U. of M., '71. Prof. of Civ. Eng. Ill. Univ., '72–'78. Prof. of Math. and Theoretical Mechanics, Cornell Univ., '80–'85. Prof. of Math. and Mechanics, Stevens Institute. Consulting Engineer. Hoboken, N. J.

1872.

CORNELIUS DONOVAN. Asst. Eng. J. L. & S. R. R., '72–'74. U. S. Asst. Eng. Lake Survey, '74–'76. Do. River and Harbor Imp. in Charge of Jetty Works at Mouth of South Pass, Miss. River, '75 to date. Port Eads, La.

JOHN H. FLAGG, M.D., '74. U. S. Asst. Eng. Harbor Imp. Eng. Colo. Cen. R. R. Eng. for Nat'l Gas Co., Chicago. Do. Alley "L" R. R. Contracting Engineer. Chicago, Ill.

*JOSHUA L. GILLESPIE, Ph B., '71. M. Am. Soc, C.E. U. S. Asst. Eng. Falls of St. Anthony, Minn., '73–'77. Do. Mississippi Riv. Imp Civ. Engineer. Died at Hartford, Conn., Aug. 22, '90.

OTTO J. KLOTZ. Field Astronomer Dept. of Interior, Canada. Engaged on Alaska Boundary Survey. Ottawa, Canada.

JOHN A. MITCHELL. Chief Eng. F. & C. and A. & B. R. Ry's, '74–'76. U. S. Asst. Eng. River and Harbor Imp. Civil Engineer and Contractor. Ludington, Mich.

THOMAS O. PERRY, A.M. Eng. U. S. Wind Eng. and Pump Co. and Eclipse Wind Eng. Co., '76–'83; With Airmotor Co., Chicago, '87 to date. Inventor and Mfgr. Chicago, Ill.

EDMUND M. SPALDING. Eng. R. R.'s in Northern Mich., '72–'78. U. S. Asst. Eng. River and Harbor Imp. Yellowstone River and Superior and Duluth Harbors, '78–'80. Locating and Constructing Eng. on R. R. Work, '80–'90. Civil Engineer. Milwaukee, Wis.

MARVIN F. TEMPLE. Levelman J. L. & S. R. R., '72–'73. Eng. on Surveys in Mexico, '81. Asst. in Gen. Office of A. T. & S. F. R. R., '82–'85. Div. Eng. C. B. & N. R. R., '85–'86. Div. Eng. C. S. F. & C. R. R., '86–'88. Do. U. P. R. R., '89–'93. Res. Eng. G. C. & S. F. R. R , '93. City Engineer. Temple, Tex.

MATTHEW TSCHIRGI, JR. Co. Surveyor, Dubuque Co., Iowa, '72–'78. City Eng. Dubuque, '76–'88. Eng. Dubuque High Bridge Co., '88. Pres't and Mgr. Dubuque Constr. Co. Dubuque, Iowa.

ROBERT S. WOODWARD. U. S. Asst. Eng. Lake Survey, '71–'82. U. S. Asst. Astronomer Transit of Venus Commission, '82–'84. Chief Geographer U. S. Geolog. Survey, '84–'90. U. S. Asst. Eng. Coast and Geodetic Survey, '90–'93. Prof. of Mechanics, Columbia Coll. New York, N. Y.

1873.

FRANK E. BLISS, LL.B., '79. Civ. Eng., '73–'75. Atty. at Law. Cleveland, O.

JOHN H. DARLING. U. S. Asst. Eng. Lake and Miss. Riv. Survey, '73–'82. Do. U. S. Harbor Imp. '83 to date. Duluth, Minn.

THOMAS EMERY. Architect and Builder. East Saginaw, Mich.

*EDWIN J. FERDON. Lumber Trade, '77–'81. Died at Detroit, Nov. 10, '81.

FRANK W. GUERNSEY. Co. Surveyor and Co. Supt. Sch., Plymouth Co., Iowa, '73–'81. Cashier Nat. Bank. Dayton, Wash.

WM. J. HEAD. Sturgeon Bay and Lake Mich. Ship Canal, '71–'72. Secy. and Treas. Ferd. Heim Brewing Co., Kansas City, '72–'76. Malster. Chicago, Ill.

JOSEPH W. PERKINS. Chief Draughtsman Bldg. Dept. A. T. & S. F. R. R. Architect. Topeka, Kas.

CLARENCE M. STEPHENS. Co. Surveyor and City Eng. Asst. Supt. Yellowstone Park. Dept. U. S. Mineral Surveyor. City Engineer. Mt. Clemens, Mich.

WM. VOIGT, JR. U. S. Asst. Eng. Lake Survey. City Eng. Detroit. Asst. Eng. A. T. & S. F. R. R., '76–'83. Sec. and Treas. Home Brewing Co. Detroit, Mich.

JOSIAH W. WILLIS. U. S. Lake Survey, '71. Prin. of Pub. Sch. 48, Buffalo, N. Y. Buffalo, N. Y.

CHAS. M. WINCHELL. U. S. Asst. Eng. Lake Survey, '74–'78. Do. Miss. Riv. Com., '78–'85, '88–'95. Do. in Charge of Surveys of Pass Cavallo and Aransas Pass, Tex., '86–'87. Eng. Street Dept. St. Louis, Mo.

1874.

HORACE BARNARD. Surveyor and Farmer. Frederick, S. Dak.

CLARENCE O. BEAN. Asst. Eng. N. P. R. R., '80–'83. City Eng. Tacoma, '83. Civ. Eng. Eng. Tacoma Land Co. Tacoma, Wash.

CHAS. L. DOOLITTLE. Prof. of Math. and Astronomy, Lehigh Univ., '75–'95. Do. Univ. of Penn. Philadelphia, Pa.

JAMES M. EVERETT. M.D. (Rush. Med. Col.) '77. Physician. De Kalb, Ill.

HORACE HOLMES. U. S. Lake Survey, '74. U. S. Harbor Imp., '75–'76. Asst. Eng. M. C. R. R., '82. Civil Engineer. Detroit, Mich.

JULIAN S. HULL. Asst. Eng. C. M. & St. P. R. R. Div. Eng. D. & R. G. R. R. Asst. Chief Eng. Tex. S. F. & No. R. R. Res. Eng. Mex. Cent. R. R. Div. Eng. Panama Canal. Locating Eng. Chilian Gov't R. R.'s. Chief Asst. Eng. Autofagasta R. R., Bolivia. Resident Eng. U. P. R. R. Eng. in Charge of Masonry, Chicago Sanitary Dist. Lockport, Ill.

HENRY B. JACKSON. Asst. Eng. R. R. Location and Const., '76. Foreman Billet Mill, Ill. Steel Co. Joliet, Ill.

VICTOR H. LANE, LL.B., '78. U. S. Lake Survey, '72–'74. Circuit Judge. Adrian, Mich.

CHARLES M. LUNGREN. Editorial Staff *Baltimore Gazette* and *Pop. Science Monthly*. Experimental Engineer. New York, N. Y.

JAMES L. RUMSEY. U. S. Dep. Surveyor for Oregon, '76–'77. Do. '82–'85. Supt. of Const. Oregonian R. R., '78–'82. Civil Engineer. Grand Rapids, Mich.

LEVI L. WHEELER, M. Am. Soc. C.E. U. S. Asst. Eng. Lake Survey, '74–'81. Do. Miss. Riv. Com., '81–'87. Do. Lake Mich., Ill. and Miss. Canal, in Charge of W. Section and Feeder. Sterling, Ill.

*ROBERT E. WILLIAMS, A.B. (Yale) '71. Dealer in R. R. and Shipping Supplies. Died at Hartford, Ct., '87.

ORRIN S. WILSON. U. S. Asst. Eng. No Boundary Survey, '73–'77. Do. Dept. of Texas, '77–'84. Asst. Eng. New York State Survey, '77–'84, '86–'87. Eng. New York State Bd. of Health, '84–'86. Asst. Eng. New York State Canals. Keuka, N. Y.

LEVI D. WINES. U. S. Lake and Missouri River Survey. Prof. Math. Ann Arbor High School. Ann Arbor, Mich.

1875.

ALBERT L. AREY. U. S. Asst. Eng. Miss. River Imp., '75–'76. Locating Eng. Gt. Northern R. R. Div. Eng. C. M. & St. P. R. R., '77–'80. Inst. in Physics, Free Academy. Rochester, N. Y.

LUCIUS BAKER. Asst. Eng. L. M. & B. R. R., '75–'76. Do. C. & O. R. R., '82. Asst. in U. S. Magnetic Observatory, Los Angeles, '83. Surveyor, '83–'87. Fruit Raising. Fresno City, Cal.

*CHAS. C. BALDWIN. U. S. Mineral Surveyor, Leadville, Colo., '75–'86. Died at Leadville, Nov., 1886.

HENRY D. BATES. U. S. Mineral Surveyor, Leadville, Colo. Mngr. of Bates Mining Co. Civil and Mining Engineer. Leadville, Colo.

*BEN BIRDSALL, JR. Lumbering Business with John A. McGraw, '75–'92. Supt. of Vermilion Lumbering Co. at Three Rivers, Can., '92–'95. Died at Montreal, P. Q., Oct. 22, '95.

CHARLES L. BUCKINGHAM, LL.B. (Columbian Univ.), '80. Asst. Exam. U. S. Patent Office, '76–'80. Counsel W. U. Tel. Co. Thompson-Houston Gen. Electric and other Co.'s. New York, N. Y.

*CHARLES A. CARNEFIX. Teacher. Died at Rock City, Ill., June 6, '89.

ROLLA C. CARPENTER, M.S. (Mich. Agl. Coll.) '76. M.M.E. (Cornell Univ.) '88, M. Am. Soc. Mech. Eng. Prof. of Math. and Civil Eng. Agrl. Coll., '76–'90. Prof. of Experimental Eng., Cornell Univ. and Consulting Engineer. Ithaca, N. Y.

LEMAN L. DICKINSON. Fruit Grower. Grand Rapids, Mich.

*J. CLEMENT EATON. U. S. Lake Survey, '76–'79. Died at Tecumseh, Mich., Feb. 1, '81.

Emerson W. Grant, M. Am. Soc. C.E. Mo. Riv. Imp., '79. Resident Eng. A. T. & S. F. R. R., '80–'87. Office Eng. Ft. W. & R. G. R. R. Locating Eng. C. S. F. & C. R. R. Asst. Eng. A. T. & S. F. R. R. Carrollton, Mo.

Joseph W. Hoover, M. Am. Soc. C.E. Eng. Indianapolis Bridge Co., '75–'77. Eng. of Const. Wrought Iron Bridge Co., Canton, O., '78–'84. Bridge Eng. and Agent, W. I. B. Co. Kansas City, Mo.

John H. Morrison. U. S. Asst. Eng. N. & N. W. Lake Survey. Do. Miss. Riv. Survey and Imp. Asst. Eng. P. Ft. W. & C. R. R. C. R. I. & P. R. R. St. P. M. & M. R. R. Civ. Eng., St. Paul, Minn. Real Estate Agt. Columbus, Ohio.

Martin L. Newton. Chief Eng. A. La Porte & Eldora R. R. Co. Surveyor and City Engineer. Waterloo, Iowa,

*George E. Pantlind, LL.B., '78. Lumber Dealer, Grand Rapids. Died in Chicago, March 23, '96.

Edward I. Parsons. Supt. of Schools, Huron, O., '76–'80. Mining and Mineral Surveying, '80-'83. Const. Eng. Pacific Cable Const. Co., '83–'90. Civil Engineer. San Francisco, Cal.

William H. Potter. Eng. Maintenance of Way, Penna. Co., '75–'95. Supt. do. '95 to date. Toledo, Ohio.

Edgar D. Root. Asst. to City Eng., Jackson, Mich., '76. Clerk M. C. R. R., and Blue Line Fast Freight. Chicago, Ill.

Walter S. Russel, M. Am. Soc. Mech. Eng. Vice-Prest. and Manager Russel Wheel and F'dy Co. Prest. Detroit Assn. of Eng'rs. Detroit, Mich.

Marcus J. Wells. Co. Surveyor. City Eng. U. S. Asst. Eng. Riv. Impt. Div. and Locating Eng. R. R. Work. Civil Engineer. Woodston, Kan.

1876.

Dewitt C. Allen. Surveyor and Farmer. Cattaraugus, N. Y.

James O. Caldwell. Prin. Salem Academy, O., '76–'79. Prof. of Math. and Astron., Wilmington Coll., O., '82. Prin. of Fountain School, Pueblo, Colo., '84. U. S. Dept. Mineral Surveyor. Woodland Park, Colo.

Frank P. Davis, M.S. (Mich. Agl. Coll.) '72. M. Am. Soc. C.E. Locating and Const. Eng. C. M. & M. R. R., '70–'74. Draughtsman State, War and Navy Dept. Bldg., Washington, '79–'81. Res. Eng. D. & Rio Grande W. R. R., '81. Chief of Party and Locating Eng. Rocky Mt. Div., Can. Pac. R. R., '82–'83. Asst. Eng. Dist. of Columbia, '84–'88. Asst. and Div. Eng. Nicaragua Ship Canal, '89–'93. Chief Asst. Eng. Nicaragua Canal Com., '95. Eng. in Charge of R. R. Const. and Sanitary Works. Port Limon, Costa Rica.

*Lewis C. Donaldson. U. S. Lake Survey, '72–74. Died at Macon, Ill., April 1, '77.

*Charles A. Marshall, M. Am. Soc. C.E. Bridge Designer, Edge Moor Iron Co, '76–'80. Const. Eng. Cambria Iron Co., '81–'84. Eng. of Tests, Cambria Iron Co., '84–'89. Drowned in Johnstown Flood, May 31, '89.

Joseph Ripley. U. S. Asst. Eng. St. Marys Falls Canal Imp. Do. in Charge of Hay Lake and 21 ft. Channel Imp. St. Mary's River. Sault Ste. Marie, Mich.

John D. Sanders. Draughtsman and Asst. Inspector Edge Moor Iron Works, '77–'78. Asst. Supt. Mine La Motte Lead Mines and Works, '79. Supt. do. '79 to date. Mine La Motte, Mo.

John M. Schaeberle. Asst. in Detroit Observatory, '78–'85. Acting Asst. Prof. of Astron., '85–'86. Instructor in Astron., '86–'88. Astronomer Lick Observatory, Univ. of Cal., '88 to date. Lick Obs., Mt. Hamilton, Cal.

Jonathan C. Shepard. Eng. U. P. R. R., '76–'81. Do U. S. River Imp. Civil Engineer. Fresno, Cal.

Lester H. Strawn. Attorney at Law. Ottawa, Ill.

Alonzo J. Tullock, M. Am. Soc. C.E. Eng. and Proprietor Mo. Valley Bridge and Iron Works. Leavenworth, Kan.

1877.

Osmer H. Aikine. First Asst. Eng. Monarch Pass, G. &. D. R. R., '79–'86. Div. Eng. B. & Mo. Riv. R. R. in Neb., '87. Civil and Mining Engineer. U. S. Dept. Mineral Surveyor. Gunnison, Colo.

Holland W. Baker. M. Am. Soc. C. E. U. S. Asst. Eng. Miss. and Mo. River Imp. Civil Engineer. St. Louis, Mo.

Wm. Burton, A.B. (Iowa Coll.) U .S .Deputy Surveyor, County Surveyor and Notary Public. Kelsey, El Dorado Co., Cal.

Benjamin A. Richards.

Edward J. Snover. City Savings Bank. Detroit, Mich.

James E. Turtle. U. S. Asst. Eng. Coosa Riv. Imp., '77–'78. Do. Muscle Shoals Canal, '79–'82. Do. Miss. Riv. Imp., '83–'86. Do Pensacola Harbor Imp. and Imp. of Rivers in Fla. and Ala. Warrington, Fla.

1878.

*Walter S. Abel. (Mining.) Assay Office, San Francisco. Died at San Francisco, May 23, '87.

George F. Allmendinger. Mngr. Delhi Mills. Do. A. A. Fruit and Vinegar Co. Do. A. A. Milling Co. Ann Arbor, Mich.

CLARENCE O. AREY, M.D. (Univ. of Pa.) In Charge of Bacteriological Lab., Govt. Exp. Sta., '93. Architect. Cleveland, Ohio.

JAMES D. DU SHANE. U. S. Asst. Eng. Miss. Riv. Imp., Plant No. 3, St. Paul to Des Moines Rapids, '78–'84. Do. Plant 2, '85. Do. St. Paul to Lake Pepin. Civil Engineer. St. Paul, Minn.

WM. V. GROVE, D.D.S. (Ohio Coll.) '81. Dentist. Buffalo, N. Y.

JOHN K. HANSON. Civil Engineer. Concord, Neb.

JOHN B. JOHNSON, M. Am. Soc. C.E. Do. Am. Soc. Mech. E. U. S. Asst. Eng. Lake Survey, '78–'80. Do, Miss. Riv. Commission, '80–'83. Prof. of Civ. Eng., Washington Univ., '83 to date. St. Louis, Mo.

TIMOTHEUS JOSENHANS, Architect. Seattle, Wash.

HENRY W. JUDD. (Mining.) Cashier, The Wick Banking and Trust Co. Cleveland, Ohio.

EUGENE G. MANN. (Mining.) Druggist and Chemist. Ann Arbor, Mich.

SEYMOUR T. MORSE, Farmer. Highland, Mich.

CHARLES F. OWEN. Chief Eng. on Steamboat, '78–'82. Eng. Harrison St. Pumping Sta, Chicago, Ill,

*JAMES SANDERSON. Asst. Eng. T. & A. A. R. R. Died at Bay City, Mich., Sept. 18, '85.

OSSIAN C. SIMONDS. Landscape Gardener and Supt. Graceland Cemetery. Chicago, Ill.

FRANK L. SIZER. Eng. D. & R. G. R. R., '81, Genl. Mngr. Empire Mining Co., '86–'88. Do. Montana Brick & Tile Co. Chief of Office of Irrigation Inquiry, Dept. of Agrl. Washington, D. C., '93. Civil and Mining Engineer. Helena, Montana.

HIRAM E. TERRY. Co. Surveyor, '79. Asst. City Eng. City Engineer. East. Saginaw, Mich.

EVERT VANPELT. Eng. Leavenworth & Topeka R. R. Civ. Eng. Yoakum, Tex.

ANDREW J. WENZELL. U. S. Asst. Eng. Harbor of Refuge, Sand Beach, '79. Ass. Eng. F. & P. M. R. R., M. C. R. R. and G. R. & I. R. R. Div. Eng. C. M. & St. P. R. R. Chief. Eng. S. F. & H. R. R. Eng. Detroit and Belle Isle Bridge. Chief Eng. L. S. & I. R. R. Eng. Union Trust Co. Bldg., Detroit. Chief Eng. Detroit & Mack. R. R. Civil Engineer. Detroit, Mich.

SIDNEY B. WIGHT. (Mining.) Assayer and Chemist, Wyandotte Silver Works, '78. Do. Detroit and Lake Superior Copper Works, '79–'82. Supt. Land Dept. D. M. & M. R. R. and Peninsular Land Co., '86–'91. Secy. to Prest. of M. C. R. R. Detroit, Mich.

1879.

CHARLES S. BEADLE. Div., Res. and Locating Eng. A. T. & S. F. R. R. Chief Eng. K. C. & E. R. R. Locating Eng. C. & St. L. Electric R. R. City Engineer. Sault Ste. Marie, Mich.

CHARLES C. BROWN, M. Am. Soc. C.E. U. S. Asst. Eng. Lake Survey, '79–'82. Prof. Civ. Eng. Rose Polytechnic Inst., '83–'86. Do. Union Coll., '86–'93. City Eng., Indianapolis, '93–'95. Consulting Eng. Central Eng. Co. Indianapolis, Ind.

CHARLES S. HENNING. Res. and Div. Eng. A. & P. R. R., '80–'83. Genl. Rdmstr. do. '83–'84. Chief Eng. J. C. K. & O. R. R., '85. Prest. Cherokee Coal Mining Co. Cherokee, Kan.

BRAYTON D. KING, (Mining.)

HORATIO T. MORLEY. Shipbuilder and Vessel Owner. Detroit, Mich.

IRVING K. POND. Architect. Chicago, Ill.

JOHN C. QUINTUS, (Mining.) M. Am. Soc. C.E. U. S. Asst. Eng., River and Harbor Imp., '79 to date. Buffalo, N. Y.

E. FRED WOOD, (Mining.) Chemist, Union Iron and Steel Co., Chicago. Do. Pittsburg Bessemer Steel Co. Supt. Bessemer Dept. Carnegie Steel Co. Asst. Supt. Homestead Steel Works. Munhall, Pa.

1880.

JOHN AYERS, Mining. Cashier, Nat. Bk. of W. Ark., '80–'82. Hardware Merchant. Ft. Smith, Arkansas.

*JOSEPH A. BEAUMONT. Died at Armordale, Kan., March 10, '85.

SAMUEL F. BEAUMONT, (Mining.) Civil and Mining Engineer. St. Louis, Mo.

EDWARD S. DAVIS. Miss. Riv. Surveys, '80–'83. Co. Surveyor, Hill Co. Texas. Hillsboro, Tex.

GEORGE L. FISHER. Architect. Omaha, Neb.

CICERO D. HILL. Asst. Eng. C. M. & St. P. R. R. Do. D. & R. G. R. R. Do. Hennepin Canal. Do. Dept. Public Works, Chicago. Civil and Consulting Engineer. Chicago, Ill.

FRANK P. SATTERLEE, (Mining.) Assayer. Shasta, Cal.

1881.

GEORGE A. BROWN. Civil Engineer. San Francisco, Cal.

RANDOLPH W. BROWN. Merchant. Rochester, (?) Minn.

JOHN W. DORST. Asst. Eng. D. & R. G. R. R., '81. U. S. Asst. Eng. Miss. Riv. Com., '81–'85. Manufacturer. New York, N. Y.

William W. Follett, M. Am. Soc. C.E. Div. Eng. N. O. & N. E. R. R., '81–'83. Eng. in Charge Red Riv. Bridge, Shreveport, La., '83–'85. Div. and Locating Eng. A. T. & S. F. R. R., '86–'88. Irrigation Survey and U. S. Geological Survey, '89. Asst. Eng. Artesian and Underflow Investigation, '90–'91. Civil Engineer. Denver, Colo.

John E. Hathaway. Contractor. Milwaukee, Wis.

David E. Hoover. Eng. Sanitary Dept. Pullman Ill. Asst. Eng. Mex. Central R. R. Surveyor and Vineyardist. Keuka, N. Y.

George A. Lederle, M. Am. Soc. C.E. Asst. Eng. Bismark Bridge, '81–'82. Do Snake Riv. Bridge, '82–'83. Eng. in Charge Keithsburg Bridge, '85. Res. Eng. Omaha Bridge, '86. Do. Willamette Bridge, '87. Do. Snake River Bridge, '88. Civil Engineer and Contractor, Firm of Christie and Lowe. Chicago, Ill.

George W. Lilly, A.B., (Ohio West.) Asst. Eng. Pullman, Ill. Do. W. & L. E. R. R. Bridge, Toledo. Do. S. C. & P. R. R. Bridge over Mo. Riv. '81–'84. Mem. of Legislature N. Dak., '89–'90. Atty. at Law, Ashley, N. Dak., '84–'95. Columbus, O.

W. Clayton Miller. Supt. Last Chance Mining Co. Mining Eng. Spokane, Wash.

1882.

Malcolm W. Edgar. Draughtsman Mich. Car Co., '82–'93. Asst. Mangr. Union Car Co. Buffalo, N. Y.

Mary Hegeler (Mrs. Paul Carus). La Salle, Ill.

William H. McEwan. Asst. Eng. D. L. & N. R. R., '82–'84. Real Estate and Lumber Dealer. Bay City, Mich.

Samuel C. Weiskopf, M. Am. Soc. C.E. Bridge Engineer. Pittsburgh, Pa.

1883.

William H. Brenton. Div. Eng. C. & A. R. R., '84–'85. Div. and Res. Eng. C. R. I. & P. R. R., '86–'88. Asst. Eng. Colo. Midland R. R., '89–'91. Res. and Locating Eng. C. R. I. & P. R. R., '92. Asst. Chief Eng. do., '94. Roadmaster do. to date. Chickasha, Ind. Ter.

Loomis B. Chapin, Assoc. M. Am. Soc. C.E. Asst. City Eng., Toledo, '83–'87. Hydraulic and Sanitary Eng., Toledo, '87–'91. Consulting Eng. City Engineer. Canton, Ohio.

George H. Chipman. Asst. Eng. V. S. & P. R. R. Bridge over Red River at Shreveport. Co. Surveyor. Civil Eng. Childress, Tex.

Frank M. Dunlap, (Mechanical). M.E., '85. M. Am. Soc. Mech. E. Draughtsman Iron Bay Mfg. Co., '83–'84. Supt. Works, Detroit Gas Light Co., '87–'88. Draughtsman F. W. Wheeler Co., Bay City, '89–'90. U. S. Asst. Eng. Detroit, Mich.

John W. Payne. U. S. Surveys and Miss. Riv. Imp., '83–'85. Asst. City Engineer. Akron, Ohio.

Job Tuthill, M. Am. Soc. C.E. Transitman, Pikes Peak R. R. '83–'84. Draughtsman Bridges and Bldgs. C. M. & St. P. R., '84. Asst. Eng. D. L. & N. R. R., '84–'89. Do. D. L. & N. R. R. and C. & W. M. R. R., '89–'90. Eng. of Bridges and Bldgs. C. & W. M. R. R. and D. L. & N. R. R. Grand Rapids, Mich.

Isaac O. Walker. Topographer Miss. Riv. Survey, '83–'85. Asst. Eng. D. L. & N. R. R., '86. Do. T. St. L. & K. C. R. R., '86–'89; Civ. Engineer. Charleston, Ill.

1884.

Henry D. Burnett. Supt. Incandescent Lamp Works, Genl. Electric Co., Lynn, Mass. Do. Canadian Genl. Electric Co. Peterborough, Ontario.

James L. Callard. Div. Eng. C. & N. W. R. R. Res. Eng. M. St. P. & S. S. M. R. R. U. S. Asst. Eng. St. Marys Falls Canal. Sault Ste. Marie, Mich.

William G. Clark, Jun. Am. Soc. C.E. Div. Eng. T. St. L. & K. C. R. R. Acting Prof. Civ. Eng. Mo. School of Mines, Rolla, Mo., '86–'87. Asst. City Eng., Toledo, O., '87. City Engineer. Toledo, Ohio.

Robert C. Gemmell, C.E., '94. M. Am. Soc. C.E. Div. Eng. A. T. & S. F. R. R. Bldg. and Water Service Eng. C. S. F. & C. R. R. Eng. Water Supply for towns in Ore., Wash., and Utah. Eng. of Sewerage System, Montesano, Wash. Eng. Irrig. Cos. Salt Lake City, Utah.

John C. Streng. Chief Draughtsman Industrial Works, Bay City, '85–'93. Do. Bucyrus Steam Shovel and Dredge Co. South Milwaukee, Wis.

1885.

Emil Bauer. Saginaw, W. S, Mich.

Edward D. Clary. Eng. United Gas Impt. Co., Phila., '86–'89. Mgr. Gas Light Co., St. Albans, Vt. Asst. Supt. Gas Light Co., Paterson, N. J. Mgr. Burlington Gas Light Co. Burlington, Iowa.

Alexander E. Kastl, M. Am. Soc. C.E. U. S. Asst. Eng. Miss. Riv. Survey and Imp., '82–'84. Do. Grand Riv. Survey, '84. Asst. City Eng., Grand Rapids, '85. Asst. Eng. Chicago Drainage Commission, '86–'87. Asst. Div. Eng. C. S. F. & C. R. R., '87–'88. First Asst. Eng. Pamico Riv. Imp. Tampico, Mex., '90–'91. Chief Eng. Brazos Riv. Channel and Dock Co., '91. U. S. Asst. Eng. Red Riv. Survey. Asst. Eng. Sanitary District, Chicago. Asst. Eng. Metropolitan Water Supply. Clinton, Mass.

CHARLES H. LANE, LL.B., (National Univ.) Draughtsman Mo. Valley Bdge and Iron Wks, '86. Prin. Exam. U. S. Patent Office. Washington, D. C.

EGBERT T. LOEFFLER, D.D.S., '88. Dentist. Saginaw, W. S., Mich.

GEORGE F. SAMUEL. Asst. City Eng. Lake View, Ill., '85–86. Do. Topeka, Kan., '87. Asst. Eng. Dept. Pub. Wks, Chicago, '88–'95. Civ. and Consulting Eng. Chicago, Ill.

FRANK C. WAGNER, (Mechanical). A.M., '84. M. Am. Soc. Mech. E. Installing Electric Lighting Plants for Thomson-Houston Elect. Co., '86–'87. Eng. in Charge Thomson-Houston Co.'s Wk, Republic of Mexico, '88–89. Asst. Prof. of Mech. Engineering, U of M. Ann Arbor, Mich.

1886.

RAYMOND W. BEACH, LL.B., '89. Asst. Eng. C. M. & St. P. R. R. Do. Kansas City Belt R. R. Atty. at Law. Chicago, Ill.

WILLIAM W. CAMPBELL. Prof. Math. Univ. of Colo., '86–'88. Inst. in Astron. U. of M., '88–'91. Astronomer, Lick Observatory. Mt. Hamilton, Cal.

LEWIS E. DUNHAM, (Mining). Asst. Chemist Joliet Steel Co., '86. Chemist Midland Blast Furnace Co., Midland, Mo., '86–87. Private Practice, '87–'89. Chemist Ashland Iron and Steel Co., '89–'92. Asst. Mgr. Ashland Iron and Steel Co. Ashland, Wis.

FRED G. FRINK. Asst. Eng. C. & A. R. R. Do. C. & N. W. R. R. Draughtsman and Estimator, Vierling, McDowell & Co. Iron Works. Supt. Constn. Snead & Co. Iron Works. Instr. Architectural Drawing, Manual Train. School. Prin. Drawing Dept. Chicago Athenæum. Chicago, Ill.

LESLIE W. GODDARD, Assoc. M. Am. Soc. C.E. U. S. Asst. Eng. River and Harbor Imp. Grand Rapids, Mich.

HOWARD G. HETZLER, Div. Eng. C. B. & Q. R. R. Road Master C. B. & Q. R. R. Chicago, Ill.

LOUIS C. HILL, (Civil). (Electrical), '90. U. S. Asst. Eng. Div. Eng. Gt. No. R. R. Div. Eng. D. R. W. & So. R. R. Prof. of Physics and Elec. Eng. State School of Mines. Golden, Colo.

WILLIAM C. KING, (Civil). Div. Eng. B. & M. R. R. Asst. in City Eng's. Office, Detroit. Detroit, Mich.

BURT McDONALD, (Mining). Architect N. Tex. Insane Asylum. Do. State Deaf and Dumb Inst. Do. Chemical Lab. and Auditorium, Tex. Univ. Do. Public Schools Lamparac and Austin, Tex. Architect. Austin, Tex.

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CLIFFORD C. SMITH, (Mechanical). Draughtsman Blake Pump Co., '86–'87. Chief Draughtsman for S. T. Wellman. Constn. Eng. Wellman Iron and Steel Co. Chester, Pa. Asst. Head Draughtsman Plate Mill Constn., Ill. Steel Co. Chief Draughtsman Locomotive Crane Dept., Brown Hoisting and Conveying Mch. Co. Cleveland, O.

ERNEST STENGER, (Civil). Assoc. M. Am. Soc. C.E. Draughtsman A. S. F. & C. R. R. Do. Union Ry. (Cable System in Kansas City). Asst. Eng. Mo. Pacific R. R. Asst. City Eng., Omaha. Omaha, Neb.

1887.

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1888.

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1889.

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PHILIP R. WHITMAN, (Mining). Mining, Bacarac, Mex., '90. Eng. Crescent Steel Works, '91–'94. Pittsburgh, Pa.

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1890.

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***WINTHROP E. GASTMAN**, (Electrical). Died at Pueblo, Colo., June 24, 1893.

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JAMES B. NELSON, (Civil). Eng. Bdge. and Struct. Iron Wks., Chicago, '90–'94. Civ. Eng. Indianapolis, Ind.

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GEORGE B. SPRINGER, (Civil). Asst. Eng. W. Chicago Park Com. Bdge. Insp. I. C. R. R. Chicago, Ill.

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1891.

GEORGE R. BRANDON, (Mechanical). Chief Draughtsman Whiting. Foundry Equipment Co. Asst. Eng. do. Harvey, Ill.

ALFRED S. CALKINS, (Civil). Eng. Corps, E. J. & E. R. R., '91–'92 Asst. City Eng. Joliet, Ill.

DWIGHT B. CHEEVER, (Mechanical). LL.B., '96. Mech. Eng. C. & W. M. and D. L. & N. Rys., '91–'92. Asst. in Elec. Eng. Ansona Elec. Co., Chicago, '93. Mgr. and Elec. Eng. West. Elec. Eng. Co of Chicago and Philadelphia. Atty. at Law. Chicago, Ill.

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HARRY J. HATCH, (Civil). Asst. to Patton & Frank, Duluth, '91. Cashier Farmer's Nat. Bk. Arkansas City, Kas.

*WM. J. HINKSON, (Civil), B.S. (Mich. Agl.) Died at Detroit, Oct. 26, '91.

JOHN T. N. HOYT, (Civil), Jun. Am. Soc. C.E. Draughtsman Pencoyd Bridge and Const. Co. Do. Brooklyn Elev. R. R. Do. L. L. Buck, N. Y. Do. R. P. & J. H. Staats, N. Y. Do. Metropolitan Traction Co. New York, N. Y.

WILLIAM T. KEATING, (Civil). With C. & N. W. R. R., '91–'92. Asst. Eng. Sanitary District, Chicago. Chicago, Ill.

ROBERT P. LAMONT, (Civil). Shailer & Schniglau Co. Eng's. and Contractors. Chicago, Ill.

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THOMAS L. WILKINSON, (Mechanical). Draughtsman M. C. Bullock Mfg. Co., Chicago. Do. Ill. Steel Co., Joliet. Inspector of Machinery do. Mech. Eng. and Editor Mech. Eng. Dept. "The Mining Industry and Review." Denver, Colo.

1892.

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ELMER L. ALLOR, (Civil). LL.B. '95. Inst. Astronomy '92. Recorder U. S. Lake Survey, '91–'94. Atty. at Law. Detroit, Mich.

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1893.

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LLEWELLYN S. POMEROY, (Civil). U. S. Sub. Insp. of Masonry St. Marys Falls, '92. Asst. Eng. Sewers, Dayton, O., '93. Farmer. Kalamazoo, Mich.

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EDWARD D. WICKES, (Electrical).

NEIL H. WILLIAMS, (Electrical), M.S., '95. Prof. of Science in High School. West Bay City, Mich.

FRANK A. WINDES, (Mechanical). Survey for Transportation Bldg. Columbian Exposition. Asst. Supt. Public Wks. Civil Eng. and Contractor. Winnetka, Ill.

CLARENCE G. WRENTMORE, (Civil). Instructor in Descriptive Geometry and Drawing, U. of M. Ann Arbor.

1894.

ABRAHAM K. ADLER, (Mechanical). Asst. to Chief Eng., Crane Elevator Co. Mech. Eng. with D. Adler, Architect. Chicago, Ill.

ROBERT L. AMES, (Mechanical). Draughtsman Street Ry. Co., Grand Rapids. Do. City Eng. Office, Kalamazoo, '92. Recorder U. S. Lake Survey, '93–'95. Asst. Exam. Patent Office. Washington, D. C.

ARCHIBALD L. BECKER, (Mechanical). Draughtsman Benton Harbor.

JOHN C. BIRD, (Mechanical). Draughtsman Fox Machine Co. Grand Rapids, Mich.

JAMES BLAIR, (Mechanical). Asst. to Prof. Cooley, '94–'95. Draughtsman for D. H. Burnham & Co., Architects. Chicago, Ill.

HOWARD E. CHICKERING, (Mechanical). Draughtsman Detroit Bridge & Iron Wks. Detroit, Mich.

HARRY W. CLARK, (Mechanical). Asst. to National Blower Co., '95. Draughtsman for E. E. Myers, Architect. Detroit, Mich.

WILLIAM C. CONANT, (Mechanical). Draughtsman for Chicago Screw Co. Do. Fraser & Chalmers. Machinist for Am. Spring Co. Die and Tool Maker, Moon Mfg. Co. Oak Park, Ill.

CLARENCE S. COOK, (Electrical). Prof. of Physics, Detroit High School. Flat Rock, Mich.

ALMON H. DEMRICK, (Electrical). Superintendent of Electrical Const. Draughtsman and Salesman of Elec. Supplies. Detroit, Mich.

HERMAN H. EYMER, (Mechanical). Draughtsman Detroit Bridge & Iron Wks., '94–'95. Do. American Bridge Wks. Chicago, Ill.

HERBERT E. FRENCH, (Civil). Asst. Supt. Woolen Mill. Reedsburg, Wis.

OSCAR GREULICH, (Civil). Draughtsman for Architect, '94–5. Do. Nat. Blower Co., Heating and Ventilating Eng. Milwaukee, Wis.

JOHN C. HAMMOND, (Mechanical). Mech. Eng. S. Lyons, Mich.

HARRIE D. HAMPER, (Mechanical). Asst. D. L. Barnes, Consult. Eng. Chicago, Ill.

CHARLES J. HARMON, (Electrical). Asst. to Chief Eng. of M. W., S. E. R. R. Chicago, Ill.

GEORGE HAYLER, JR., (Mechanical). Supt. Elect. Light & Power Co. Van Wert, O.

MAX LICHTENSTEIN, (Civil). Civil Eng. Elgin, Ill.

DANIEL B. LUTEN, (Civil). Instructor Civil Eng. U. of M., '94–'95. Instructor Civil Eng. Purdue Univ. LaFayette, Ind.

RALPH W. NEWTON, (Civil). Draughtsman Detroit B. & I. Wks., '94–'95. Do. Columbus Bridge Wks., '95. Draughtsman Carnegie Steel Co. Pittsburgh, Pa.

FREDERICK C. NOBLE, (Civil). Prin. Asst. Eng. C. S. & S. W. R. R. Draughtsman with Purdy & Henderson, Civil Engrs. New York.

ROBERT K. PALMER, (Civil). Draughtsman Am. Bridge Wks., '94. Do. New Columbus Bridge Co., '95. Do. Elmira Bridge Co., Ltd. Elmira, N. Y.

WILLIAM P. PARKER, (Civil). Draughtsman with Detroit Heating & Lighting Co. Do. Detroit Metal & Heating Co. Do. Detroit Dry Dock Co. Do. Kenwood Bridge Co. Do. Whiting Foundry Equipment Co. Do. Massillon Bridge Co. Massillon, O.

RICHARD QUINN, (Civil). Asst. on U. S. Eng. Corps, Miss. River Imp. New Orleans, La.

OSCAR ROBERTS, (Civil). Missionary. Batanza, West Africa.

FRED ROGERS, (Electrical). Electrician, V. Milling and Electric Co. Vermillion, S. Dak.

FRED A. SAGER, (Electrical). Asst. Prof. Physics, Univ. of Ill. Urbana, Ill.

WILLIAM S. SMITH, (Mechanical). Mech. Eng. Aurora, Ill.

GOLDWIN STARRETT, (Mechanical). Architectural Draughtsman with D. H. Burnham & Co. Chicago, Ill.

GEORGE C. WEARE, (Mechanical). With Sherwin Williams Co., Paint and Color Mfrs. Cleveland, O.

JOSEPH WEARE, (Civil). Draughtsman New Columbus Bridge Co. Columbus, O.

1895.

LOUIS W. ANDERSON, (Civil). Civil Eng. Albion, Mich.

WALTER M. AUSTIN, (Electrical). Electrical Eng. Philadelphia, Pa.

WILLIAM G. BILLINGS, (Electrical). Asst. to R. R. Commissioner. Lansing, Mich.

AUGUST BLAESS, (Civil). Asst. on Eng. Corps of D. & M. R. R. Bay City, Mich.

ABRAHAM L. BURGAN, (Electrical), M.S. '96. Asst. in Elect. Dept. Calumet & Hecla Mining Co., '91–'92. Post-Graduate Work U. of M. Lake Linden, Mich.

PLATT R. BUSH, (Civil). Levelman on location of Munsing R. R., '95. Asst. Eng. Lehigh Valley Coal Co's. Docks. S. Chicago, Ill.

WILLIAM R. CALDWELL, (Civil). Asst. City Eng. Sault Ste Marie, Mich.

WALLACE W. CHICKERING, (Mechanical). Draughtsman Gas Engine Wks. Beloit, Wis.

HOWARD M. COX, (Mechanical). Draughtsman Denver Engineering Wks., '95. Prospector. N. Cripple Creek, Colo.

GEORGE A. DAMON, (Electrical). Asst. to B. J. Arnold, Electric Eng. Chicago, Ill.

JAMES H. DICKSON, (Electrical), A.B., '94. Asst. to Field & Hinchman Elec. Engrs. Detroit, Mich.

JAMES H. DUNBAR, (Civil). Draughtsman New Columbus Bridge Co. Columbus, O.

JOHN H. DYE, (Civil). Eng. to Kingdom of Korea. Seoul, Korea.

HARVEY G. GILKERSON, (Civil). Eng. Corps, St. L. & K. C. R. R., '95. Transitman on Colo. Springs and C. C. R. R. Colorado Springs, Colo.

R. PROSPER GUSTIN, (Mechanical). Draughtsman Baldwin Loco. Wks. Philadelphia, Pa.

ALEXANDER M. HAUBRICH, (Electrical). Electric Light and Telephone Const. Toledo, O.

BRYSON D. HORTON, (Electrical). Wireman at East Saginaw, '95. Asst. Eng. on Belle Isle. Detroit, Mich.

JOHN HULST, (Mechanical). Draughtsman and Estimator, Whiting Foundry Equipment Co. Harvey, Ill.

MILTON B. HUNTOON, (Electrical). Teacher High School. Menominee, Mich.

CLARENCE T. JOHNSTON, (Civil). Eng. Corps. State of Wyoming. Irrigation and Reservoir Work. Cheyenne, Wyoming.

HORACE W. KING, (Civil). Civil Eng. Minneapolis, Minn.

HARRY V. KNIGHT, (Electrical). Electrical Eng. Alpena, Mich.

DAVID LE FAVOUR, (Civil). Student in Mech. E., U. of M. Bay City, Mich.

HERMAN B. LEONARD, (Electrical). Stock and Time Keeper, Toledo Elec. St. Ry., '95. Draughtsman and Eng. for Bissell, Dodge & Erner Co. Toledo, Ohio.

RICHARD R. LYMAN, (Civil). Prof. of Math. and Eng., Brigham Young Academy. Provo, Utah.

THOMAS K. MATHEWSON, (Civil). U. S. Sub-Inspector Miss. River Imp., '95. Asst. in City Eng's Office. Muscatine, Iowa.

WILLIAM J. MELCHERS, (Electrical). Electrical Eng. with Telephone Exchange. E. Saginaw, Mich.

CHARLES A. MINER, (Civil). Asst. U. S. Eng. New Orleans, La.

CHARLES H. MORSE, JR., (Mechanical). Asst. in Mfg. Dept., Fairbanks, Morse & Co. Post Grad. Student, U. of M. Ann Arbor, Mich.

JOHN F. NICHOLS, (Mechanical). Draughtsman, F. W. Wheeler & Co. West Bay City, Mich.

ELBERT NICHOLSON, (Mechanical). Asst. to Geo. S. Pierson, Kalamazoo. Asst. to City Eng., Sterling, Ill. With John A. Cole, Civ. Eng. Chicago, Ill.

MARIAN S. PARKER, (Civil). With Purdy & Henderson. New York.

ALBERT S. PASSOLT, (Electrical). Asst. to Field & Hinchman, Elec. Engrs. Detroit, Mich.

*CLARENCE H. PERRY, (Civil). Eng. Corps, Chicago N. Side R. R. Died at Chicago, March 11, 1896.

SETH E. ROBERTS, (Civil). Eng. and Draughtsman with W. H. Ashwell & Co. Detroit, Mich.

WILBUR G. SALTER, (Mechanical). Clerk and First Asst. Draughtsman, City Water Office. Chicago, Ill.

WILLIAM SCHAAKE, (Mechanical). Draughtsman, Kenwood Bridge Co., '95. Designer, The Sligh Bicycle Co. Grand Rapids, Mich.

EMMET SCOTT, (Mechanical). Stationary Eng. Min fg. Establishment, '95. Asst. in Office of Same. La Porte, Ind.

FREDERICK G. SKINNER, (Civil). Draughtsman and Transitman, Metropolitan St. Ry. Kansas City, Mo.

LESTER A. STANLEY, (Electrical). Elect. Eng. Kalamazoo, Mich.

ISAAC F. STERN, (Civil). With Wm. Sooy Smith, '95. Draughtsman with Purdy & Henderson. Chicago, Ill.

EDWARD M. ST. JOHN, (Civil). U. S. Insp. Masonry, St. Marys Falls Canal. Civil Eng. with L. S. & M. S. R. R. Toledo, O.

ROBERT C. STEVENS, (Mechanical). A.B., '94. Mech. Eng. with Atlas Iron Wks. Indianapolis, Ind.

WELLINGTON C. TATE, (Electrical). Supt. Const. Ohio Penitentiary. Mansfield, O.

NELSON J. TUBBS, (Civil). Civil Eng. Dexter, Mich.

FRANK F. VAN TUYL, (Electrical). Elect. Eng. with Gilbert Wilkes. Detroit, Mich.

VANCE P. WILKINS, (Civil). Draughtsman, City Engr's. Office, Akron, O. Asst. Eng. St. L. & S. W. R. R. Texarkana, Texas.

GEORGE B. WILLCOX, (Mechanical). Mech Eng. Bay City, Mich.

HOMER W. WYCKOFF, (Electrical). Supt. of Const. underground system City Lighting, Detroit, '94. Do. for System of Conduits, Toledo, Central Union Telephone Co., '95. Asst. Eng., Corps of Central Union Telephone Co. Chicago, Ill.

The Department of Engineering desires to acknowledge its indebtedness to the editors of the Technic for the labor and expense involved in collecting and arranging the detailed information accompanying the above list of alumni.

UNIVERSITY OF MICHIGAN

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Department of Engineering

ANNOUNCEMENT

FOR THE YEAR

1896-97

ANN ARBOR, MICH.:
PUBLISHED BY THE UNIVERSITY
1896

ANN ARBOR
The Inland Press
1896

PRELIMINARY NOTICE.

Each student is required to deposit in the Registrar's box attached to the door of the President's office, on or before the second Monday of each semester (October 12, 1896, and March 1, 1897), a list of all the courses, both prescribed and elective, which he intends to take during the semester; and is requested to avoid as far as possible any change in his choice after making this deposit. Blanks upon which to make this statement may be procured at the Steward's office.

Students entering upon their work more than two weeks after the beginning of a semester are required to submit their lists of studies to the Faculty for approval.

Each course must be designated by its subject, its number, its specific title, the number of times a week, and the name of the instructor, as given in THIS ANNOUNCRMENT, *e. g.*,

Mathematics 1, four hours, Mr. Lyman.
Physics 1, five hours, Dr. St. John.

The courses should be named in the order in which they are found in THIS ANNOUNCEMENT, *French before German, Mathematics before Chemistry, etc.*

RULES RELATING TO ADMISSION CONDITIONS.

All conditions imposed at an examination for admission
must be [illegible]ved du[illegible] the year following the date of the
exa[illegible] St[illegible] have any admission conditions
ov[illegible] at [illegible] of their second year of resi-
[illegible] no[illegible] to join their classes until such
are[illegible]

RULES RELATING TO ADVANCED CREDIT.

a. All students, whether candidates for a degree or pursuing select studies, who apply for advanced standing, must present to the Registrar a statement showing the amount of work done in the subjects in which credit is asked.

b. No credit will be given in any subject for high school work unless the subject has been pursued in the high school for at least one year.

c. The application for advanced standing should be made to the Registrar immediately after matriculation; and the Registrar will furnish a blank form for presentation to the professors in charge of the several subjects named in the blank.

d. Credits must be secured and returned to the Registrar before the beginning of the holiday vacation in December, or (if the candidate be matriculated after that date), before the beginning or the spring recess in April.

e. No credits will be given for advanced standing after the dates named in (*d*).

f. An account once closed cannot be reopened without special permission from the Faculty.

RULES RELATING TO ELECTION OF STUDIES.

I. The maximum number of hours a week a student may elect without special permission of the Faculty is sixteen.

In case of exceptional proficiency additional hours may be granted by the Faculty on special request; but in all cases requests for permission to take an additional number of hours must be made in writing on a blank form provided by the Dean, and must be deposited in the Dean's box on or before the *first Monday* of the semester during which the additional work is desired.

N. B.—Students who are making up preparatory studies in the Ann Arbor High School are required to deduct the time spent in that school from the maximum number of hours allowed them in the University.

II. For first year students is recommended the following scheme of election, or such parts thereof as may be needed in making up a suitable amount of work:—

First semester: French D, or German C, two hours; Mathemactics 1, four hours; Drawing 1, two hours; Drawing 4, three hours; English 1, two hours, or Shop Practice 1a, three hours.

Second semester: French—or German D, two hours; Mathematics 2, four hours; Physics 1, five hours; Drawing 5, three hours; English 1, two hours, or Shop Practice 1a, three hours.

III. Except as provided in (I) and (II) each student may elect his studies and may pursue them in any order he may choose, subject only to the following restrictions:

(*a*) Before entering on any study the student must give the professor in charge satisfactory evidence that he is prepared to pursue it with advantage.

(*b*) If he is a candidate for a degree, he must at some time take all the studies "prescribed" for the degree he seeks.

(*c*) No student will be allowed to elect merely a part of a course without special permission of the Faculty.

(*d*) No credit will be allowed to a student for work in any course, unless the election of the work is formally made and reported to the Registrar before the work is begun.

(*e*) After the second Monday of each semester no study shall be taken up or dropped without special permission of the Faculty. All requests for permission to take up or drop studies must be made in writing on specially provided blank forms and in accordance with the rules printed thereon.

(*f*) The Faculty will require a student to drop a part of his work at any time, if in its opinion he is undertaking too much; or to take additional work, if it thinks he is not sufficiently employed.

(*g*) The Faculty reserves the right to withdraw the offer of any study not chosen by at least six persons.

IV. After matriculation, a student shall not, without special permission of the Faculty, be admitted to examination in any one of the courses given, until he has received in the University the regular instruction in such course.

REQUIREMENTS FOR GRADUATION.

For information in regard to the courses prescribed for graduation, see the Annual Announcement of this department, pages 31 to 34.

COURSES OFFERED IN 1896–97.

The courses of study for 1896–97 will be substantially as described in the following paragraphs, though a few changes in the subjects and authors taught, and in the instructors may be expected.

Courses given in the Department of Literature, Science, and the Arts may be elected by students in the Department of Engineering.

The assignment of rooms is in many cases only provisional. U. H. stands for University Hall, T. H. for Tappan Hall.

FRENCH.

FIRST SEMESTER.

B. Narrative Prose. *Tu*, *Th*. Sec. I, at 2. Room 12, U. H. Sec. II, at 3. Room 12, U. H. Mr. EFFINGER.

D. Scientific Reading. *Tu*, *Th*, at 3. Room 2, U. H. Mr. FRANÇOIS.

SECOND SEMESTER.

A. Beginner's Course. Grammar and Reader. *M*, *W*, *Th*, *F*. Sec. I, at 3. Room J. Mr. EFFINGER. Sec. II, at 9. Room ——. Mr. FRANÇOIS.

C. Descriptive Prose. *Tu*, *Th*, at 2. Room ——. Mr. EFFINGER.

GERMAN.

FIRST SEMESTER.

A. Beginner's Course. Thomas's German Grammar, Part 2, and a German Reader. *M, Tu, W, F.* Sec. I, at 8. Room 26, U. H. Sec. II, at 3. Room 23, U. H. Mr. LESSING.

C. Descriptive Prose. *Th, S,* at 8. Room 26, U. H. Mr. LESSING.

SECOND SEMESTER.

B. Narrative Prose. Easy Stories. Sec. I, *Tu, Th,* at 8. Sec. II, *Th, S,* at 11. Room 23, U. H. Mr. LESSING.

D. Technical Prose. Schroot's Der Dampf. *W, F,* Sec. I, at 8. Sec. II, at 3. Room 23, U. H. Mr. LESSING.

ENGLISH AND RHETORIC.

FIRST SEMESTER.

1. Paragraph-Writing. *M, W,* at 3. Another section may be formed at *an hour arranged with instructor.* Mr. STRAUSS.

SECOND SEMESTER.

1. Paragraph-Writing. Sec. I, *Th, S,* at 10. Sec. II, *M, W,* at 3. Mr. STRAUSS.

MATHEMATICS.

Students of engineering are required to take in order Courses 1, 2, 3, 4, and 6. They are also required to take Course 1*b*, unless they have passed a satisfactory examination for admission in plane trigonometry, but no credit toward graduation is given to engineering students for Course 1*b*.

FIRST SEMESTER.

1. Algebra and Analytical Geometry (I), *M, Tu, W, F.* Sec. I, at 8. Room 27, U. H. Mr. GODDARD. Sec. II, at 9. Room 1, T. H. Mr. LYMAN. *M, Tu, Th, F.* Sec. III, at 3. Room 27, U. H. Mr. HALL. *M, W, F, S.* Sec. IV, at 8; Sec. V, at 9. Room 17, U. H. MR. COAR.

1*b*. Plane Trigonometry. *M, W.* Sec. I, at 1. Room 27. U. H. Mr. GODDARD. *Tu, Th.* Sec. II, at 10; Sec. III, at 1. Room 27, U. H. Mr. GODDARD.

3. Calculus. *M, Tu, W, Th, F.* Sec. I, at 8. Room H. Professor ZIWET. Sec. II, at 8. Room 1, T. H. Mr. LYMAN. Sec. III, at 2; Sec. IV, at 3. Room 19, U. H. Dr. GLOVER.

6. Calculus and Mechanics (II). *M, Tu, W, Th.* Sec. I, at 11; Sec. II, at 2. Room H. Professor ZIWET. *M, W, F, S.* Sec. III, at 10. Room 1, T. H. Mr. LYMAN.

SECOND SEMESTER.

2. Analytical Geometry (II). *M, Tu, W, F.* Sec. I, at 8; Sec. II, at 9. Room 27, U. H. Mr. GODDARD. Sec. III, at 9. Room 1, T. H. Mr. LYMAN. Sec. IV, at 3. Room 17, U. H. Mr. COAR. *M, W, F, S.* Sec. V, at 8. Room 17, U. H. Mr. COAR.
4. Calculus and Mechanics (I). *M, Tu, W, Th, F.* Sec. I, at 8. Room 1, T. H. Mr. LYMAN. Sec. II, at 9. Room H. Professor ZIWET. Sec. III, at 2; Sec. IV, at 3. Room 19, U. H. Dr. GLOVER.

PHYSICS.

FIRST SEMESTER.

The lectures in Physics are given in the lecture room of the Physical Laboratory. Courses in Electrical Engineering will be found under that title.

1. Mechanics, Sound and Light. *M, Tu, W, Th, F,* at 11. Dr. ST. JOHN.

Course 1 is open to those who have passed an entrance examination in physics, and to all others who have sufficient preparation. A knowledge of plane trigonometry is indispensable.

After 1896–97 Course 1 will be given in the second semester only.

3. Physical Laboratory Work for Beginners. The course may be elected as—

3*a*. *Three times a week, M, W, F,* 1–3. Fee $3.

3*b*. *Twice a week,* 1–3. Dr. GUTHE. Fee $2.

Course 3 must be preceded or accompanied by Course 1.

Students presenting note-books from High School physical laboratories approved by this department, may be allowed three hours credit instead of two for Course 3*b*.

4. Primary and Secondary Batteries. Recitations, *F,* at 8; laboratory work, *once a week.* Dr. GUTHE. Fee $1.

Course 4 must be preceded by Courses 1, 2, 3*a*, or 3*b*, and a course in general or analytical chemistry.

After 1896–97 Course 4 will be given in the second semester instead of the first.

5. Electrical Measurements. Lectures and recitations, *F,* at 3. Professor CARHART. Laboratory work, *three times a week between* 8 *and* 10, 10 *and* 12 *or between* 1 *and* 3. Assistant Professor PATTERSON and Dr. GUTHE. Fee $3.

Course 5 must be preceded by Courses 1, 2, and 3*a*, or 3*b*. A knowledge of calculus is also required.

6. Sound. Violle: Acoustique. *Once a week;* laboratory work, *twice a week.* Dr. ST. JOHN. Fee $2.

Course 6, must be preceded by Courses 1, and 3*a*, or 3*b*. A knowledge of calculus is required.

7. Electricity and Magnetism: Mascart and Joubert. *Tu*, *Th*, *F*, at 8. Assistant Professor PATTERSON.

Course 7 must be preceded by Course 2. A knowledge of calculus is also required.

9. Theory of Heat: Preston. *Twice a week.* Professor CARHART.

13. Geometrical Optics. *M*, *W*, at 8. Dr. ST. JOHN.

Course 13 must be preceded by Course 1. A knowledge of calculus is required.

14. Sound. Advanced laboratory work, *twice a week. Hours to be arranged with instructor.* Dr. ST. JOHN. Fee $2.

Course 14 must be preceded by Course 6.

SECOND SEMESTER.

1. Mechanics, Sound and Light. Lectures, *Tu*, *Th*, *S*, at 11. Recitations, *twice a week.* Dr. ST. JOHN.

Course 1 is open to those who have passed an entrance examination in physics, and to all others who have sufficient preparation. A knowledge of plane trigonometry is indispensable.

2. Electricity and Magnetism. *M*, *Tu*, *W*, *Th*, at 11. Professor CARHART and Assistant Professor PATTERSON.

Course 2 must be preceded by Course 1 and by a course in general or analytical chemistry.

2*a*. Heat. Lecture, *F*, at 11. Recitations, *once a week.* Professor CARHART and Assistant Professor PATTERSON.

Course 2*a* must be preceded by Course 1.

After 1896–97 Courses 2 and 2*a* will be given in the first semester instead of the second.

3. Physical Laboratory Work for Beginners. Repetition of Course 3, first semester. This course may be elected as—

3*a*. Sec. I, *M*, *W*, *F*, 9–11. Sec. II, *M*, *W*, *F*, 1–3. Fee $3.

3*b*. Sec. III, *Tu*, *Th*, 9–11. Fee $2. Assistant Professor PATTERSON and Dr. GUTHE.

8. Heat. Laboratory Work, *twice a week. Hours to be arranged with instructor.* Dr. GUTHE. Fee $2.

Course 8 must be preceded by Course 2*a*.

10. Electricity and Magnetism: Mascart and Joubert. *Twice a week.* Assistant Professor PATTERSON.

Course 10 must be preceded by Course 7.

ANN ARBOR
THE INLAND PRESS
1896

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Mathematics 1, four hours, Mr. Lyman.
Physics 1, five hours, Dr. St. John.

The courses should be named in the order in which they are found in THIS ANNOUNCEMENT, *French before German, Mathematics before Chemistry, etc.*

RULES RELATING TO ADMISSION CONDITIONS.

All conditions imposed at an examination for admission must be removed during the year following the date of the examination. Students who have any admission conditions outstanding at the beginning of their second year of residence, will not be allowed to join their classes until such conditions are removed.

RULES RELATING TO ADVANCED CREDIT.

a. All students, whether candidates for a degree or pursuing select studies, who apply for advanced standing, must present to the Registrar a statement showing the amount of work done in the subjects in which credit is asked.

b. No credit will be given in any subject for high school work unless the subject has been pursued in the high school for at least one year.

c. The application for advanced standing should be made to the Registrar immediately after matriculation; and the Registrar will furnish a blank form for presentation to the professors in charge of the several subjects named in the blank.

d. Credits must be secured and returned to the Registrar before the beginning of the holiday vacation in December, or (if the candidate be matriculated after that date), before the beginning or the spring recess in April.

e. No credits will be given for advanced standing after the dates named in (*d*).

f. An account once closed cannot be reopened without special permission from the Faculty.

RULES RELATING TO ELECTION OF STUDIES.

I. The maximum number of hours a week a student may elect without special permission of the Faculty is sixteen.

In case of exceptional proficiency additional hours may be granted by the Faculty on special request; but in all cases requests for permission to take an additional number of hours must be made in writing on a blank form provided by the Dean, and must be deposited in the Dean's box on or before the *first Monday* of the semester during which the additional work is desired.

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III. Except as provided in (I) and (II) each student may elect his studies and may pursue them in any order he may choose, subject only to the following restrictions:

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(*d*) No credit will be allowed to a student for work in any course, unless the election of the work is formally made and reported to the Registrar before the work is begun.

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The assignment of rooms is in many cases only provisional. U. H. stands for University Hall, T. H. for Tappan Hall.

FRENCH.

FIRST SEMESTER.

B. Narrative Prose. *Tu*, *Th*. Sec. I, at 2. Room 12, U. H. Sec. II, at 3. Room 12, U. H. Mr. EFFINGER.

D. Scientific Reading. *Tu*, *Th*, at 3. Room 2, U. H. Mr. FRANÇOIS.

SECOND SEMESTER.

A. Beginner's Course. Grammar and Reader. *M*, *W*, *Th*, *F*. Sec. I, at 3. Room J. Mr. EFFINGER. Sec. II, at 9. Room ——. Mr. FRANÇOIS.

C. Descriptive Prose. *Tu*, *Th*, at 2. Room ——. Mr. EFFINGER.

GERMAN.

FIRST SEMESTER.

A. Beginner's Course. Thomas's German Grammar, Part 2, and a German Reader. *M, Tu, W, F.* Sec. I, at 8. Room 26, U. H. Sec. II, at 3. Room 23, U. H. Mr. LESSING.

C. Descriptive Prose. *Th, S,* at 8. Room 26, U. H. Mr. LESSING.

SECOND SEMESTER.

B. Narrative Prose. Easy Stories. Sec. I, *Tu, Th,* at 8. Sec. II, *Th, S,* at 11. Room 23, U. H. Mr. LESSING.

D. Technical Prose. Schroot's Der Dampf. *W, F,* Sec. I, at 8. Sec. II, at 3. Room 23, U. H. Mr. LESSING.

ENGLISH AND RHETORIC.

FIRST SEMESTER.

1. Paragraph-Writing. *M, W,* at 3. Another section may be formed at *an hour arranged with instructor.* Mr. STRAUSS.

SECOND SEMESTER.

1. Paragraph-Writing. Sec. I, *Th, S,* at 10. Sec. II, *M, W,* at 3. Mr. STRAUSS.

MATHEMATICS.

Students of engineering are required to take in order Courses 1, 2, 3, 4, and 6. They are also required to take Course 1*b*, unless they have passed a satisfactory examination for admission in plane trigonometry, but no credit toward graduation is given to engineering students for Course 1*b*.

FIRST SEMESTER.

1. Algebra and Analytical Geometry (I), *M, Tu, W, F.* Sec. I, at 8. Room 27, U. H. Mr. GODDARD. Sec. II, at 9. Room 1, T. H. Mr. LYMAN. *M, Tu, Th, F.* Sec. III, at 3. Room 27, U. H. Mr. HALL. *M, W, F, S.* Sec. IV, at 8; Sec. V, at 9. Room 17, U. H. MR. COAR.

1*b*. Plane Trigonometry. *M, W.* Sec. I, at 1. Room 27. U. H. Mr. GODDARD. *Tu, Th.* Sec. II, at 10; Sec. III, at 1. Room 27, U. H. Mr. GODDARD.

3. Calculus. *M, Tu, W, Th, F.* Sec. I, at 8. Room H. Professor ZIWET. Sec. II, at 8. Room 1, T. H. Mr. LYMAN. Sec. III, at 2; Sec. IV, at 3. Room 19, U. H. Dr. GLOVER.

6. Calculus and Mechanics (II). *M, Tu, W, Th.* Sec. I, at 11; Sec. II, at 2. Room H. Professor ZIWET. *M, W, F, S.* Sec. III, at 10. *Room* 1, T. H. Mr. LYMAN.

SECOND SEMESTER.

2. Analytical Geometry (II). *M, Tu, W, F.* Sec. I, at 8; Sec. II, at 9. Room 27, U. H. Mr. GODDARD. Sec. III, at 9. Room 1, T. H. Mr. LYMAN. Sec. IV, at 3. Room 17, U. H. Mr. COAR. *M, W, F, S.* Sec. V, at 8. Room 17, U. H. Mr. COAR.
4. Calculus and Mechanics (I). *M, Tu, W, Th, F.* Sec. I, at 8. Room 1, T. H. Mr. LYMAN. Sec. II, at 9. Room H. Professor ZIWET. Sec. III, at 2; Sec. IV, at 3. Room 19, U. H. Dr. GLOVER.

PHYSICS.

FIRST SEMESTER.

The lectures in Physics are given in the lecture room of the Physical Laboratory. Courses in Electrical Engineering will be found under that title.

1. Mechanics, Sound and Light. *M, Tu, W, Th, F,* at 11. Dr. ST. JOHN.

   Course 1 is open to those who have passed an entrance examination in physics, and to all others who have sufficient preparation. A knowledge of plane trigonometry is indispensable.

   After 1896–97 Course 1 will be given in the second semester only.

3. Physical Laboratory Work for Beginners. The course may be elected as—

3*a*. *Three times a week, M, W, F,* 1–3. Fee $3.

3*b*. *Twice a week,* 1–3. Dr. GUTHE. Fee $2.

Course 3 must be preceded or accompanied by Course 1.

Students presenting note-books from High School physical laboratories approved by this department, may be allowed three hours credit instead of two for Course 3*b*.

4. Primary and Secondary Batteries. Recitations, *F,* at 8; laboratory work, *once a week.* Dr. GUTHE. Fee $1.

   Course 4 must be preceded by Courses 1, 2, 3*a*, or 3*b*, and a course in general or analytical chemistry.

   After 1896–97 Course 4 will be given in the second semester instead of the first.

5. Electrical Measurements. Lectures and recitations, *F,* at 3. Professor CARHART. Laboratory work, *three times a week between* 8 *and* 10, 10 *and* 12 *or between* 1 *and* 3. Assistant Professor PATTERSON and Dr. GUTHE. Fee $3.

   Course 5 must be preceded by Courses 1, 2, and 3*a*, or 3*b*. A knowledge of calculus is also required.

6. Sound. Violle: Acoustique. *Once a week;* laboratory work, *twice a week.* Dr. ST. JOHN. Fee $2.

Course 6, must be preceded by Courses 1, and 3*a*, or 3*b*. A knowledge of calculus is required.

7. Electricity and Magnetism: Mascart and Joubert. *Tu, Th, F*, at 8. Assistant Professor PATTERSON.

Course 7 must be preceded by Course 2. A knowledge of calculus is also required.

9. Theory of Heat: Preston. *Twice a week.* Professor CARHART.

13. Geometrical Optics. *M, W*, at 8. Dr. ST. JOHN.

Course 13 must be preceded by Course 1. A knowledge of calculus is required.

14. Sound. Advanced laboratory work, *twice a week. Hours to be arranged with instructor.* Dr. ST. JOHN. Fee $2.

Course 14 must be preceded by Course 6.

SECOND SEMESTER.

1. Mechanics, Sound and Light. Lectures, *Tu, Th, S*, at 11. Recitations, *twice a week.* Dr. ST. JOHN.

Course 1 is open to those who have passed an entrance examination in physics, and to all others who have sufficient preparation. A knowledge of plane trigonometry is indispensable.

2. Electricity and Magnetism. *M, Tu, W, Th*, at 11. Professor CARHART and Assistant Professor PATTERSON.

Course 2 must be preceded by Course 1 and by a course in general or analytical chemistry.

2*a*. Heat. Lecture, *F*, at 11. Recitations, *once a week.* Professor CARHART and Assistant Professor PATTERSON.

Course 2*a* must be preceded by Course 1.

After 1896–97 Courses 2 and 2*a* will be given in the first semester instead of the second.

3. Physical Laboratory Work for Beginners. Repetition of Course 3, first semester. This course may be elected as—

3*a*. Sec. I, *M, W, F*, 9–11. Sec. II, *M, W, F*, 1–3. Fee $3.

3*b*. Sec. III, *Tu, Th*, 9–11. Fee $2. Assistant Professor PATTERSON and Dr. GUTHE.

8. Heat. Laboratory Work, *twice a week. Hours to be arranged with instructor.* Dr. GUTHE. Fee $2.

Course 8 must be preceded by Course 2*a*.

10. Electricity and Magnetism: Mascart and Joubert. *Twice a week.* Assistant Professor PATTERSON.

Course 10 must be preceded by Course 7.

11. Theory of Light: Preston. Recitations, *twice a week.* Laboratory work, *twice a week.* Dr. ST. JOHN.

Course 11 must be preceded by Course 6. A knowledge of calculus is also required.

12. Electrical Measurements. Continuation of Course 5. Lectures, *once a week.* Laboratory work, *twice a week. Hours to be arranged with instructor.* Dr. GUTHE. Fee $2.

15. Light. Advanced laboratory work, *twice a week. Hours to be arranged with instructor.* Dr. ST. JOHN. Fee $2.

Course 15 must be preceded by Course 11.

16. Chemical Physics. Electrochemistry. Theories of Solutions and Electrolytes, including the Osmotic Theory of the Voltaic Cell. Lectures, *twice a week.* Laboratory work, *once a week.* Dr. GUTHE. Fee $1.

Course 16 must be preceded by Course 5 and Courses 1 and 4 in general chemistry.

CHEMISTRY.

FIRST SEMESTER.

1. Elementary Inorganic Chemistry, Descriptive and Experimental. Lectures and recitations, *M, W, F,* at 1. Lower Lecture Room, Medical Building. Mr. HIGLEY.

EITHER FIRST OR SECOND SEMESTER.

2. Laboratory Work in General Inorganic Chemistry. *Three or more hours. Any morning or afternoon, between* 9 *and* 12, *and* 1 *and* 4. Mr. HIGLEY, Mr. LICHTY, and Dr. SHERMAN.

Course 2 must be preceded or accompanied by Course 1 or an equivalent. It is supplementary to Course 1 and covers in the laboratory the ground covered by lectures in Course 1. Students should elect at least five hours of laboratory work in Course 2 during the year, in order to complete the beginning work in inorganic chemistry. Those wishing to distribute five hours of work through two semesters, may elect three hours in their first and two hours in their second semester.

SECOND SEMESTER.

3. Qualitative Analysis. *Five hours.* Recitations, *Tu, Th,* at 9; laboratory work, *three times a week.* Professor JOHNSON.

This Course is continued in Course 3*a* in the second semester, and these two courses, 3 and 3*a*, together, are equivalent to Course 1, and cover the same ground.

Course 3 must be preceded by Course 2, 3 or 4 in General Chemistry, or an equivalent.

METALLURGY.

FIRST SEMESTER.

2. Micro-Metallography. The study of the microscopic structure of metals as related to their physical and chemical properties. Laboratory work with reading. *One hour.* Professor E. D. CAMPBELL.

Course 2 can be taken only by those who have taken Course 1 in metallurgy, and have received special permission.

SECOND SEMESTER.

1. Fuel and Refractory Material, Iron and Steel. *Three hours.* Professor E. D. CAMPBELL.

Course 1 must be preceded by Course 1 or Course 3 in analytical chemistry, or by Course 1 in General Chemistry.

ASTRONOMY.

A knowledge of logarithms and of spherical trigonometry is required for all courses in astronomy except 1 and 2. In Course 3, however, a short review of spherical trigonometry is given.

FIRST SEMESTER.

1. General Astronomy. *M, W, F*, at 2. Room 22, U. H. Professor HALL.

Course 1 requires a knowledge of plane trigonometry. Students who have passed in astronomy for entrance will receive only two hours' credit for this course.

3. Spherical Astronomy, including Transformation of Coordinates, Precession, Nutation, Aberration, Refraction, Parallax. *Three hours. Hours arranged with instructor.* Room 22, U. H. Mr. TOWNLEY.

Course 3 must be preceded by Course 1 or its equivalent. A knowledge of calculus is also required.

5. Practical Exercises in Computing. *Three hours. Hours arranged with instructor.* Room 22, U. H. Professor HALL.
6. Theory and Computation of Parabolic Orbits, Correction of Orbits. *Five hours. Hours arranged with instructor.* Room 22, U. H. Professor HALL.

Course 6 should be preceded by Course 16 in mathematics.

EITHER FIRST OR SECOND SEMESTER.

2. Elementary Practical Course. *One hour. Hour arranged with instructor.* Observatory. Mr. TOWNLEY.

Course 2 requires a knowledge of trigonometry and general astronomy.

4. Practical Astronomy. Use of sextant and portable transit. *Three hours. Hours arranged with instructor.* Observatory. Mr. TOWNLEY.

Course 4 requires a knowledge of differential and integral calculus.

9. Extended Practical Course. *Hours and credit arranged with instructor.* Observatory. Professor HALL and Mr. TOWNLEY.

Course 9 is open only to such students as receive special permission from the instructor.

SECOND SEMESTER.

7. Theory and Computation of Elliptic Orbits. Theory of Special Perturbation. *Five hours. Hours arranged with instructor.* Room 22, U. H. Professor HALL.

Course 7 should be preceded by Course 16 in mathematics.

8. Spherical Astronomy. Continuation of Course 3, including Theory and Computation of Eclipses and Theory of Instruments. *Three hours. Hours arranged with instructor.* Room 22, U. H. Mr. TOWNLEY.

10. Lectures with collateral reading on Recent Progress in Astro-Physical Astronomy. *One hour. Hour arranged with instructor.* Mr. TOWNLEY.

11. Mathematical Theories of Planetary Motions. *Three hours. Hours arranged with instructor.* Room 22, U. H. Professor HALL.

MINERALOGY.

FIRST SEMESTER.

1. Short Course. Lectures and practice. *Two hours.* Lectures, *Tu, Th,* at 9; practice, *twice a week, at hours arranged with instructor.* Room 6, T. H. Professor PETTEE.

For Course 1 an elementary knowledge of chemistry is desirable, though not required. A second lecture section, at 10, may be organized, if the demand is sufficient.

SECOND SEMESTER.

1. Short Course. Lectures and practice. *Two hours.* Lectures, *Tu, Th,* at 3; practice, *twice a week, at hours arranged with instructor.* Room 6, T. H. Professor PETTEE.

For Course 1 an elementary knowledge of chemistry is desirable, though not required.

DRAWING.

All the work in drawing is given in the new Engineering Building.

In Courses 7 and 8, attendance in the drawing room on the days indicated is required for *one hour* in addition to the hour specified, and the hours of attendance should be consecutive, if possible.

FIRST SEMESTER.

1. Elementary Drawing. Practice, *two hours.* Sec. I, *M*, *W*, 1–3. Sec. II, *Tu*, *Th*, 10–12. Sec. III, *Tu*, *Th*, 1–3. Room 9. Mr. GOULDING.

4. Free-Hand Drawing; Pen and Ink Drawing; Sketching. *Three hours. M, W, F*, Sec. I, 8–10. Sec. II, 10–12. Room 12. Professor DENISON. Sec. III, 9–11. Sec. IV, 10–12. Room 14. Mr. WRENTMORE.

10. Continuation of Course 8. *Twice a week*, 10–12. Room 12. Professor DENISON or Miss HUNT.

Course 10 must be preceded by Courses 4 and 8.

In Course 10 the section is limited in number.

13. Water Color Drawing. *Three hours. Hours arranged with instructor.* Room 12. Professor DENISON or Miss HUNT.

Course 13 must be preceded by Course 8. It is to be taken only by special permission.

SECOND SEMESTER.

5. Descriptive Geometry. *Three hours. M, W, F.* Sec. I, at 8. Room 3. Sec. II, at 9. Room 9. Mr. GOULDING. Sec. III, at 9. Sec. IV, at 10. Room 3. Mr. WRENTMORE. *Tu, W, Th.* Sec. V, at 10. Room 9. Mr. GOULDING.

Attendance in the drawing room is required for one hour per week in addition to the hours above specified; *time to be arranged with instructor.*

Course 5 must be preceded by Course 1.

6. Shades, Shadows, and Perspective. *Three hours. M, W, F*, at 9, *and such additional time as may be found necessary to complete the work.* Room 10. Professor DENISON.

Course 6 must be preceded by Course 5.

7. Free-Hand Drawing (advanced). *M, W, F*, at 10 or 11. Room 12. Professor DENISON or Miss HUNT.

In Course 7 the section is limited in number.

8. Architectural and Water-Color Drawing. *Tu, Th*, at 10 or 11. Room 12. Professor DENISON or Miss HUNT.

Course 8 must be preceded by Course 1 or 4. The section is limited in number.

14. Stereotomy. *Two hours. Tu, Th*, at 9, *and such additional time as may be found necessary to complete the work.* Room 10. Professor DENISON.

Course 14 must be preceded by Course 5.

16. Free-Hand Lettering. *Two hours. Tu, Th*, 8–10. Room 14. Mr. WRENTMORE.

Course 16 must be preceded by Course 1.

SHOP PRACTICE.

EITHER FIRST OR SECOND SEMESTER.

All courses in shopwork are under the supervision of Superintendent C. G. TAYLOR, to whom application must be made for assignment to sections and arrangement of hours.

Each of the Courses 1*a*, 2*a*, 3*a*, and 4*a* embraces five lectures on workshop appliances and materials, which will be given by Superintendent C. G. TAYLOR, *Saturday mornings, hours to be arranged.*

1*a*. Wood work and pattern work. *Three hours.* Sec. I, *M*, *F*, 1–5; Sec. II, *Tu*, *Th*, 8–12; Sec. III, *Tu*, *Th*, 1–5; Sec. IV, *W*, 1–5, *S*, 8–12. Mr. PURFIELD. Fee $5.

2*a*. Forging. *Two hours.* *Tu*, *Th*, Sec. I, 8–10; Sec. II, 10–12; Sec. III, 1–3; *M*, *F*, Sec. IV, 8–10; Sec. V, 10–12; Sec. VI, 1–3. Mr. ORR. Fee $5.

3*a*. Foundry Work. *Two hours.* Sec. I, *Tu*, *Th*, 9–12; Sec. II, *Tu*, *Th*, 1–4; Sec. III, *S*, 7½–12½. Mr. WINSLOW. Fee $5.

4*a*. Iron Work. *Three hours.* Sec. I, *M*, *W*, *F*, 9–12; Sec. II, *Tu*, *Th*, *S*, 9–12; Sec. III, *M*, *W*, *F*, 1–4. Mr. SMOOTS. Fee $5.

The hours announced for Courses 1*a*, 2*a*, 3*a*, and 4*a*, are subject to slight changes to accommodate students. These courses may be elected as 1*b*, 2*b*, 3*b*, and 4*b*, by advanced students. *Hours arranged with the instructor.*

Special arrangements will be made for students who desire to take more advanced work in the shop courses with a view to preparing themselves for teaching these subjects.

SURVEYING.

All the work in surveying is given in the new Engineering Building.

1. Lectures and Field Practice with Instruments. *Four hours.* *Tu*, *W*, *Th*, *F*, 1–4. Room 5. Professor J. B. DAVIS.

The field practice in Course 1 continues during favorable weather until Christmas.

4. Use of Instruments. *Tu*, *W*, *Th*, 9–11. *One hour.* Room 5. Professor J. B. DAVIS.

Course 4 covers the first *six weeks* of the semester, and is for students of mechenical engineering who take Course 1 in drawing the remainder of the semester.

6. Continuation of Course 5. Phototopography. Field work and drawing, *one hour.* *M*, 1–4. Room 4. Professor J. B. DAVIS.

The ability to make photographic negatives will be of service.

SECOND SEMESTER.

2. Continuatian of Course 1. Lectures and text-book, *five hours.* *M, Tu, W, Th, F,* at 2. Room 9. Professor J. B. DAVIS.

Course 2 must be preceded by Course 1.

3. Field Work in Camp. *Four weeks, six days each week,* 8–12 *and* 1–5. Professor J. B. DAVIS.

Except by special permission Course 3 is open only to students who are working for a degree in civil engineering.

5. Topography. Transit and Stadia. Plane Table. Field work and drawing, *three hours. Thirteen weeks, M, Tu, W, Th,* 1–4. Rooms 5 and 9. Professor J. B. DAVIS.

Course 5 must be counted as four times a week in making up elections.

7. Geodesy. Geodetic Methods. Lectures and text-book, *three hours. Twelve weeks, M, Tu, W, Th, F,* at 10. Room 5. Professor J. B. DAVIS.

Course 7 must be counted as five times a week in making up elections, and must be preceded by Courses 1 and 2 in surveying.

CIVIL ENGINEERING.

The work in civil engineering is conducted in the new Engineering Building.

FIRST SEMESTER.

1. Municipal Engineering. Lectures and text-book, *five hours. M, Tu, W, Th, F,* at 8. Room 5. Professor J. B. DAVIS.

4. Graphical Analysis of Structures. *Tu, Th,* at 9. Room 4. Professor GREENE.

Course 4 must be preceded by Course 3.

5. Strength and Resistance of Materials. *M, W,* Sec. I, at 9; Sec. II, at 10. Room 4. Professor GREENE.

Sec. I is for students in civil engineering. Sec. II for others.

Course 5 must be preceded by Course 6 in mathematics.

6. Engineering. Theory of construction, *F,* at 9. Room 4. Professor GREENE.

Course 6 must be preceded by Course 6 in mathematics.

7. Engineering Design. *Five hours. M, Tu, W, Th, F,* 2–5. Room 14. Professor GREENE.

Course 7 accompanies Courses 5 and 6.

SECOND SEMESTER.

2. Tests of Materials. *One hour. S,* 9–12. Engineering Laboratory. Professor GREENE.

3. Graphical Analysis of Structures. Sec. I, *M*, *W*, at 10; Sec. II, *Tu*, *Th*, at 10. Room 4. Professor GREENE.
   Sec. II is for students in civil engineering; Sec. I, for others.
   Course 3 requires at least a limited knowledge of statics.
8. Engineering. Theory of construction, *M*, *Tu*, *Th*, *F*, at 9. Room 4. Professor GREENE.
9. Hydraulics. *W*, at 9; Room 4. Professor GREENE.
10. Water Supply and Sewerage. *F*, at 10. Room 4. Professor GREENE.

MECHANICAL ENGINEERING.

FIRST SEMESTER.

5*a*. Principles of Mechanism. *Three hours.* *Tu*, *Th*, 9–11, *and additional time arranged with instructor.* Room 10. Professor DENISON.
   Course 5*a* is for students of mechanical and electrical engineering, and must be preceded by Course 1 or 1*a* in mathematics, and by Courses 1 and 5 in drawing.

5*b*. Principles of Mechanism. *Two hours.* *Tu*, *Th*, 9–11. Room 12. Professor DENISON.
   Course 5*b* is for students of civil engineering, and must be preceded by Course 1 or 1*a* in mathematics, and by Courses 1 and 5 in drawing.

8*a*. Prime Movers. Water wheels and steam engines, *Tu*, *Th*, at 10. Room 7. Professor COOLEY and Assistant Professor WAGNER.

8*b*. Prime Movers. Water wheels, *Tu*, at 10. Room 7. Professor COOLEY.
   Course 8*b* is intended for those who have taken Course 9; and 8*a* for all others.
   Courses 8*a* and 8*b* must be preceded by Course 7*a* or 7*b*.

10. Theory of Machine Design. *W*, *F*, at 11. Room 7. Professor COOLEY and Assistant Professor WAGNER.
   Course 10 must be preceded or accompanied by Course 5 in civil engineering.
11. Design of General Machinery. *Three hours.* *M*, *W*, *F*, 1–4. Engineering Laboratory. Professor COOLEY.
   Course 11 should be accompanied by Course 10.
12. Thermodynamics. Hot-air and gas engines, air compressors, and refrigerating machines, *Tu*, *Th*, at 9. Room 7. Assistant Professor WAGNER.
6. Course 12 must be preceded by Course 7 and by Courses 1 and 2 in physics.
   The abi[illegible] and Ventilation. *Two hours.* *Tu*, *Th*, at 11. Room 7. ssor COOLEY.

EITHER FIRST OR SECOND SEMESTER.

6*a*. Design of Shop Machinery. *Two hours.* First semester, *Tu*, *Th*, 9–12. Second semester, Sec. I, *Tu*, *Th*, 9–12; Sec. II, *W*, *F*, 9–12. Drawing Room, Engineering Laboratory. Superintendent C. G. TAYLOR.

Course 6*a* must be preceded by Courses 1, 5, and 9 in drawing, and preceded or accompanied by Course 5 in mechanical engineering.

16. Steam Engineering. Practical work in the laboratory, *three hours.* First semester, *Tu*, *Th*, 2–5; *S*, 9–12. Second semester, *M*, *W*, *F*, 2–5. Professor COOLEY and Assistant Professor WAGNER.

Course 16 must be preceded by Course 8 or Course 9.

SECOND SEMESTER.

7*a*. Dynamics of Machinery. *M*, *W*, Sec. I, at 8; Sec. II, at 10. Room 7. Assistant Professor WAGNER.

7*b*. Dynamics of Machinery. *One hour. First half of semester. M*, *W*, Sec. I, at 8; Sec. II, at 10. Room 7. Assistant Professor WAGNER.

Course 7*b* is the same as the first half of Course 7*a*, and is intended for students of civil engineering.

Courses 7*a* and 7*b* must be preceded by Course 6 in mathematics, and by Course 1 in physics.

9. Steam Engines. Valve gears, *M*, *W*, *F*, at 9. Room 7. Assistant Professor WAGNER.

Course 9 must be preceded or accompanied by Course 7*a* or 7*b*.

13. Machinery and Mill Work. *Tu*, *Th*, at 10. Room 7. Professor COOLEY.

14. Design of Engines and Boilers *Two hours.* *Tu*, *Th*, 1–4. Engineering Laboratory. Professor COOLEY.

ELECTRICAL ENGINEERING.

The courses in Electrical Engineering are given in the Physical Laboratory. Courses 1, 2, 4*a*, 5 (formerly 4, 5, 8*a*, and 13), 6 (formerly 9 and 14), and 7 are required of candidates for the degree in Electrical Engineering.

FIRST SEMESTER.

1. Primary and Secondary Batteries: Carhart's Primary Batteries. Recitation, *F*, at 8. Laboratory work once a week. Dr. GUTHE. Fee $1.

Course 1 must be preceded by Courses 1, 2 and 3, in physics, and a course in general or in analytical chemistry.

2. Electrical Measurements: Carhart and Patterson's Electrical Measurements. *Four hours.* Recitation, *F*, at 3. Professor CARHART. Laboratory work three times a week between 8–10, 10–12 or 1–3. Assistant Professor PATTERSON and Dr. GUTHE. Fee $3.

Course 2 must be preceded by Courses 1, 2 and 3 in physics; a knowledge of calculus is also required.

5. Alternate Current Apparatus. *Two hours.* *M*, *W*, at 8. Professor CARHART.

Course 5 must be preceded by Course 4.

6. Distribution of Electricity and Photometry. *Three hours.* Lectures, *Tu*, *Th*, at 1. Laboratory work, *once a week.* Assistant Professor PATTERSON. Fee $1.

Course 6 must be preceded by Course 4.

7. Design of Electrical Machinery and Appliances. *Two hours.* Professor CARHART.

Course 7 must be preceded by Courses 4 and 5.

SECOND SEMESTER.

3. Electrical Measurements: Continuation of Course 2. *Three hours.* Lecture, *once a week.* Laboratory work, *twice a week.* Dr. GUTHE. Fee $2.

4*a*. Electro-Dynamic Machinery: Thompson's Dynamo-Electric Machinery. *Four hours.* Lectures and recitations, *Tu*, *Th*, at 8. Professor CARHART. Laboratory work, *Tu*, *Th*, 1–3 or 3–5. Professor CARHART and Assistant Professor PATTERSON. Fee $2.

4*b*. *Three hours.* Recitations and Lectures as above. Laboratory work, *Tu* or *Th*, 1–3, or 3–5. Fee $1.

Courses 4*a* and 4*b* must be preceded by Course 2.

8. The Magnetic Circuit: Du Bois. *Two hours.* Lectures and recitations, *hours to be arranged.* Assistant Professor PATTERSON.

Course 8 must be preceded by Course 2 in physics and a course in calculus.

MARINE ENGINEERING.

Course 2 is designed for graduate students and undergraduates who have had the necessary preliminary training. Courses 1 and 3 are for graduates.

FIRST SEMESTER.

1. Naval Architecture.

SECOND SEMESTER.

2. Marine Engines. *M*, *Tu*, *Th*, at 9. Room 11. Professor COOLEY.
3. Ship-Building.

MINING ENGINEERING.

SECOND SEMESTER.

1. Mining. *M, Tu, W, Th, F,* at 11. Room 6, T. H. Professor PETTEE.
   This course is open only to those who are candidates for the degree of Bachelor of Science in mining engineering, and must be preceded by Course 2 in mineralogy and Course 8 in geology.

GYMNASIUM WORK.

Classes are formed in both semesters for gymnasium work under the charge of the Director of the Gymnasium; but no credit toward graduation is given therefor.

SCHEDULE OF EXAMINATIONS.

Time of Exercise.*	Monday 8	Monday 9	Monday 10	Monday 11	Monday 1	Monday 2	Monday 3
Time of Examination.	Monday **8-10**	Tuesday **8-10**	Thursday **8-10**	Friday **8-10**	Thursday **4-6**	Tuesday **2-4**	Wednesday **2-4**
Time of Exercise.	Tuesday 8	Tuesday 9	Tuesday 10	Tuesday 11	Tuesday 1	Tuesday 2	Tuesday 3
Time of Examination.	Saturday **8-10**	Wednesday **8-10**	Monday **2-4**	Thursday **2-4**	Friday **4-6**	Saturday **4-6**	Friday **2-4**
Time of Exercise.	Wednesday 8	Wednesday 9	Wednesday 10	Wednesday 11	Wednesday 1	Wednesday 2	Wednesday 3
Time of Examination.	Saturday **10-12**	Monday **10-12**	Friday **10-12**	Wednesday **10-12**	Monday **4-6**	Tuesday **10-12**	Thursday **10-12**

* NOTES: By the **Time of Exercise** is meant the time of the first Exercise of the week in any given Course. For example: If a Course is given Monday at 3, Wednesday at 3, and Friday at 10, it is said to be given **Monday at 3.** By referring to Monday 3, in the Schedule, it will be seen that the examination falls upon Wednesday 2-4. In Courses not provided for the examinations will be held at hours arranged so as not to conflict with the schedule.

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UNIVERSITY OF MICHIGAN

DEPARTMENT OF ENGINEERING

ANNOUNCEMENT

FOR THE YEAR

1897-'98

ANN ARBOR, MICH.:
PUBLISHED BY THE UNIVERSITY.
1897.

THE COURIER OFFICE, PRINTERS AND BINDERS,
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PRELIMINARY NOTICE.

Each student is required to deposit in the Registrar's box attached to the door of the President's office, on or before the second Monday of each semester (October 11, 1897, and February 28, 1898), a list of all the courses, both prescribed and elective, which he intends to take during the semester; and is requested to avoid as far as possible any change in his choice after making this deposit. Blanks upon which to make this statement may be procured at the Steward's office.

Students entering upon their work more than two weeks after the beginning of a semester are required to submit their lists of studies to the Faculty for approval.

Each course must be designated by its subject, its number, its specific title, the number of times a week, and the name of the instructor, as given in THIS ANNOUNCEMENT, *e. g.*,

Mathematics 1, four hours, Mr. Lyman,
Physics 1, five hours, Asst. Prof. Reed.

The courses should be named in the order in which they are found in THIS ANNOUNCEMENT, *French before German, Mathematics before Chemistry, etc.*

RULES RELATING TO ADMISSION CONDITIONS.

All conditions imposed at an examination for admission must be removed during the year following the date of the examination. Students who have any admission conditions outstanding at the beginning of their second year of residence, will not be allowed to join their classes until such conditions are removed.

RULES RELATING TO ADVANCED CREDIT.

a. All students, whether candidates for a degree or pursuing select studies, who apply for advanced standing, must present to the Dean a statement showing the amount of work done in the subjects in which credit is asked.

b. No credit will be given in any subject for high school work unless the subject has been pursued in the high school for at least one year.

c. The application for advanced standing should be made to the Dean immediately after matriculation; and the Dean will furnish a blank form for presentation to the professors in charge of the several subjects named in the blank.

d. Credits must be secured and returned to the Dean before the beginning of the holiday vacation in December, or (if the candidate be matriculated after that date) before the beginning of the spring recess in April.

e. No credits will be given for advanced standing after the dates named in (*d*).

f. An account once closed cannot be reopened without special permission from the Faculty.

RULES RELATING TO ELECTION OF STUDIES.

I. The maximum number of hours a week a student may elect without special permission of the Faculty is *sixteen*. First year students are referred to (II).

In case of exceptional proficiency additional hours may be granted by the Faculty on special request; but in all cases requests for permission to take an additional number of hours must be made in writing on a blank form provided by the Dean, and must be deposited in the Dean's box on or before the *first Monday* of the semester during which the additional work is desired.

N. B.—Students who are making up preparatory studies in the Ann Arbor High School are required to deduct the time spent in that school from the maximum number of hours allowed them in the University.

II. For students entering in 1897 as first year students, the following scheme of studies is *required*, except so far as any credits in advance will leave a place for substitutions. The student who enters with two years of German will take German through the first year. The student who enters with two years of French will take French the first year. Students taking French in the first year will elect Forging and not Woodwork during the first semester.

First Year, First Semester.

French or German, Course D, *Three hours.*
English, Course 1. *Two hours.*
Mathematics, Course 1, *Four hours.*
Drawing, Course 1. *Two hours.*
Drawing, Course 4. *Three hours.*
Shop Practice, Course 2*a*, Forging, or Course 1*a*, Woodwork. *Two hours. Total, sixteen hours.*

First Year, Second Semester.

French or German, Course E. *Three hours.*
Mathematics, Course 2. *Four hours.*
Physics, Course 1. *Five hours.*
Drawing, Course 5. *Four hours.*
Shop Practice, Course 1*a*, Woodwork, or Course 2*a*, Forging. *Two hours. Total, eighteen hours.*

At the end of the first year the student will select his line of work.

Second Year, First Semester.

German or French, Course A. *Three hours.*
Mathematics, Course 3. *Five hours.*
Physics, Course 2. *Five hours.*

For Civil Engineers.

Chemistry, Course 2. *Three hours.*
Mineralogy, Course 1. *Two hours. Total, eighteen hours.*

For Mechanical Engineers.

Shop Practice, Course 3*a*, Foundry, or Course 4*a*, Ironwork. *Two or three hours.*

Shop Practice, Course 1*b*, Woodwork. *Two hours. Total, seventeen or eighteen hours.*

For Electrical Engineers.

Physics, Course 3*b*. *Two hours.*

Shop Practice, Course 3*a*, Foundry, or Course 4*a*, Ironwork. *Two or three hours. Total, seventeen or eighteen hours.*

Second Year, Second Semester.

German or French, Course B. *Three hours.*

Mathematics, Course 4. *Five hours.*

English, Course 1*a*. *Two hours.*

For Civil Engineers.

Drawing, Course 14. *Two hours.*

Geology, Course 1. *Two hours.*

Physics, Course 3*c*. *Three hours. Total, seventeen hours.*

For Mechanical Engineers.

Shop Practice, Course 4*a*, Ironwork, or Course 3*a*, Foundry. *Three or two hours.*

Mechanical Engineering, Course 4. *Two hours.*

Physics, Course 3*c*. *Three hours. Total, seventeen or eighteen hours.*

For Electrical Engineers.

Shop Practice, Course 4*a*, Ironwork, or Course 3*a*, Foundry. *Three or two hours.*

Shop Practice, Course 1*b*, Woodwork. *Two hours.*

Electrical Engineering, Course 1. *Two hours. Total, sixteen or seventeen hours.*

III. Except as provided in (I) and (II) each student may elect his studies and may pursue them in any order he may choose, subject only to the following restrictions:

(*a*) Before entering on any study the student must give the instructor in charge satisfactory evidence that he is prepared to pursue it with advantage.

(*b*) If he is a candidate for a degree, he must at some time take all the studies "prescribed" for the degree he seeks.

(*c*) No student will be allowed to elect merely a part of a course without special permission of the Faculty.

(*d*) No credit will be allowed to a student for work in any course, unless the election of the work is formally made and reported to the Registrar before the work is begun.

(*e*) After the second Monday of each semester no study shall be taken up or dropped without special permission of the Engineering Faculty. All requests for permission to take up or drop studies must be made in writing on specially provided blank forms and in accordance with the rules printed thereon.

(*f*) The Faculty will require a student to drop a part of his work at any time, if in its opinion he is undertaking too much; or to take additional work, if it thinks he is not sufficiently employed.

(*g*) The Faculty reserves the right to withdraw the offer of any study not chosen by at least six persons.

IV. After matriculation, a student shall not, without special permission of the Faculty, be admitted to examination in any one of the courses given, until he has received in the University the regular instruction in such course.

REQUIREMENTS FOR GRADUATION.

Students who entered previous to 1897, may refer for information in regard to the courses prescribed for graduation, to the University Calendar, 1896–7, pages 142 to 144.

For students entering in 1897 the requirements will be as follows:—

After October, 1897, the requirements for graduation will be one hundred and thirty hours, as follows:—

GENERAL REQUIREMENTS.

French and German. *Fifteen hours.*
English: Courses 1, 1*a*.
Mathematics: Courses 1, 2, 3, 4, 6.
Physics: Courses 1, 2.

Chemistry: Course 2.
Drawing: Courses 1, 4, 5.
Shop Practice: Courses 1*a*, 2*a*.
Civil Engineering: Courses 3, 5.

SPECIAL REQUIREMENTS.

In Civil Engineering.

Physics: Course 3*c*.
Astronomy: Course 4.
Mineralogy: Course 1.
Geology: Course 1.
Drawing: Course 14.
Surveying: Courses 1, 2, 3, 5, 6.
Civil Engineering: Courses 4, 6, 7, 8, 9.
Mechanical Engineering: Courses 5*b*, 7*b*, 8.
Electrical Engineering: Course 4*b*.

In Mechanical Engineering.

Physics: Course 3*c*.
Metallurgy: Course 1.
Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.
Surveying: Course 4.
Civil Engineering: Course 9.
Mechanical Engineering: Courses 4, 5*a*, 6*a*, 7*a*, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18.
Electrical Engineering: Course 4*b*.

In Electrical Engineering.

Physics: Course 3*b*.
Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.
Mechanical Engineering: Courses 5*a*, 6*a*, 7*a*, 8, 9.
Electrical Engineering: Courses 1, 2, 3, 4*a*, 5, 6, 7.

In addition to the above requirements the student must complete an amount of work sufficient to secure *one hundred and thirty hours of credit.*

COURSES OFFERED IN 1897–98.

The courses of study for 1897–98 will be substantially as described in the following paragraphs, though a few changes in the subjects and authors taught, and in the instructors may be expected.

Courses given in the Department of Literature, Science, and the Arts may be elected by students in the Department of Engineering. For additional work in Language and Science, see the announcement of the former department.

The assignment of rooms is in many cases only provisional. U. H. stands for University Hall, T. H. for Tappan Hall.

FRENCH.

FIRST SEMESTER.

[A. Beginner's Course. *Three hours.*
This course will not be given in 1897–8.]

B. Narrative Prose. *Tu, Th,* at 2. Room 12, U. H. Mr. ———.
After 1897–8, Course B will be *Three hours.*

D. Advanced Scientific Reading. *Tu, Th, F,* at 9. Room 18, U. H. Mr. ——— .

SECOND SEMESTER.

C. Descriptive Prose. *Tu, Th,* at 2. Room J. Mr. ———.
After 1897–8, Course C will be *three hours.*

E. Scientific Reading. *M, W, F,* at 10. Room —. Mr. ———.

GERMAN.

FIRST SEMESTER.

A. Elementary Course. Thomas's German Grammar, and a German Reader. *M, W, F,* at 8. Room 23, U. H. Mr. ———.

D. Descriptive Prose. Sec. I, *M, W,* at 9, *S,* at 8. Room 23, U. H. Mr. ———. Sec. II, *M, W, F,* at 11. Room 26, U. H. Mr. ———.

SECOND SEMESTER.

B. Elementary Course continued. *Tu, Th, S,* at 8. Room 23, U. H. Mr. ———.

E. Scientific Prose. Sec. I, *M, W, F,* at 3. Sec. II, *M, W, F,* at 2. Room 23, U. H. Mr. ———.

ENGLISH.

FIRST SEMESTER.

1. Paragraph Writing. Sec. I, *M, W,* at 9. Sec. II, *Tu, Th,* at 9. Sec. III, *Tu, Th,* at 11. Room 3, Eng. Bldg.

MATHEMATICS.

Students of engineering are required to take in order Courses 1, 2, 3, 4, and 6. They are also required to take Course 1*b*, unless they have passed a satisfactory examination for admission in plane trigonometry, but no credit toward graduation is given to engineering students for Course 1*b*. Courses 5, 7, 8, 9, 10, 12, 13, 15, 19, and 20, are for undergraduates and graduates; Courses 11, 14, 16, 17, 18, 21, 22, 23, 24, 25, 26, 27, 28, 29, and 30 are primarily for graduates, though undergraduates of exceptional ability are admitted by special permission.

FIRST SEMESTER.

1. Algebra and Analytic Geometry (I). *M, Tu, Th, F.* Sec. I, at 8. Room 17, U. H. Dr. GLOVER. Sec. II, at 8. Room 27, U. H. Mr. GODDARD. Sec. III, at 10. Room 1, T. H. Mr. LYMAN. Sec. IV, at 10. Room 19, U. H. Mr. HALL.

1*b*. Plane Trigonometry. *Two hours. Hours arranged with instructor.* Sec. I. Sec. II. Room 27, U. H. Mr. GODDARD.

3. Calculus. *M, Tu, W, Th, F.* Sec. I, at 8. Room H. Professor ZIWET. Sec. II, at 8. Room 1, T. H. Mr. LYMAN. Sec. III, at 2; Sec. IV, at 3. Room 19, U. H. Assistant Professor MARKLEY.

5. Solid Analytic Geometry. *Tu, Th,* at 1. Room 1, T. H. Professor BEMAN.

6. Calculus and Mechanics (II). *M, W, F, S.* Sec. I, at 10. *M, Tu, W, Th.* Sec. III, at 2. Room H. Professor ZIWET. *M, W, F, S.* Sec. II, at 11. Room 1, T. H. Mr. LYMAN.

7. Projective Geometry (I). *M, W, F,* at 11. Room 19, U. H. Assistant Professor MARKLEY.

9. Differential Equations. *M, Tu, Th,* at 2. Room 1, T. H. Professor BEMAN.

11. Theory of Functions (I). *Three hours. Hours arranged with instructor.* Room 19, U. H. Assistant Professor MARKLEY.

12. Higher Algebra (I). *Three hours. Hours arranged with instructor.* Room 17, U. H. Dr. GLOVER.

16. Advanced Mechanics (II). *Two hours. Hours arranged with instructor.* Room H. Professor ZIWET.

21. Advanced Differential and Integral Calculus (I). *Two hours. Hours arranged with instructor.* Room 1, T. H. Professor BEMAN.

23. Theory of Substitutions (I). *Two hours. Hours arranged with instructor.* Room 17, U. H. Dr. GLOVER.

25. Partial Differential Equations (I). *Two hours. Hours arranged with instructor.* Room H. Professor ZIWET.

[27. Theory of Numbers (I). *Two hours. Hours arranged with instructor.* Room 19, U. H. Assistant Professor MARKLEY.
Not given in 1897–98.]

[29. Theory of Invariants. *Two hours. Hours arranged with instructor.* Room 17, U. H. Dr. GLOVER.
Not given in 1897–98.]

SECOND SEMESTER.

2. Analytic Geometry (II). *M, Tu, Th, F.* Sec. I, at 8. Room 17, U. H. Dr. GLOVER. Sec. II, at 8. Room 27, U. H. Mr. GODDARD. *M, Tu, W, F.* Sec. III, at 10. Room 1, T. H. Mr. LYMAN. Sec. IV, at 10. Room 19, U. H. Mr. HALL.

2*b*. Spherical Trigonometry. *Two hours. Hours arranged with instructor.* Room 17, U. H. Dr. GLOVER.

4. Calculus and Mechanics (I). *M, Tu, W, Th, F.* Sec. I, at 8. Room 1, T. H. Mr. LYMAN. Sec. II, at 8. Room H. Professor ZIWET. Sec. III, at 2; Sec. IV, at 3. Room 19, U. H. Assistant Professor MARKLEY.

8. Projective Geometry (II). *M, W, F,* at 11. Room 19, U. H. Assistant Professor MARKLEY.

10. Quaternions. *Hours and credit arranged with instructor.*

13. Higher Algebra (II). *Three hours. Hours arranged with instructor.* Room 17, U. H. Dr. GLOVER.

14. Theory of Functions (II). *Three hours. Hours arranged with instructor.* Room 19, U. H. Assistant Professor MARKLEY.

15. Advanced Mechanics (I). *Three hours. Hours arranged with instructor.* Room H. Professor ZIWET.

[17. Linear Differential Equations. *Two hours. Hours arranged with instructor.* Room 1, T. H. Professor BEMAN.
Not given in 1897–98.]

18. Higher Plane Curves. *Tu, Th,* at 1. Room 1, T. H. Professor BEMAN.

22. Advanced Differential and Integral Calculus (II). *Two hours. Hours arranged with instructor.* Room 1, T. H. Professor BEMAN.

24. Theory of Substitutions (II). *Two hours. Hours arranged with instructor.* Room 11, U. H. Dr. GLOVER.

26. Partial Differential Equations (II). *Two hours. Hours arranged with instructor.* Room H. Professor ZIWET.

[28. Theory of Numbers (II). *Two hours. Hours arranged with instructor.* Room 19, U. H. Assistant Professor MARKLEY.
Not given in 1897–98.]

[30. Theory of Invariants (II). *Two hours. Hours arranged with instructor.* Room 17, U. H. Dr. GLOVER.
Not given in 1897–98.]

PHYSICS.

FIRST SEMESTER.

The lectures in Physics are given in the lecture room of the Physical Laboratory. Courses in Electrical Engineering will be found under that title.

2. Heat, Electricity, and Magnetism. Lectures, *M, W, F,* at 11. Recitations, *twice a week.* Professor CARHART and Assistant Professor REED.

Course 2 must be preceded by Course 1 and by a course in general or analytical chemistry.

3. Physical Laboratory Work for Beginners. The course may be elected as—

3*a*. *Three times a week, M, W, F,* 1–3.

3*b*. *Twice a week,* 1–3. Professor PATTERSON and Assistant Professor REED.

Course 3 must be preceded or accompanied by Course 1.

Students presenting note-books from High School physical laboratories approved by this department, by electing 3*a*, may be allowed three hours credit for two hours' work.

7. Mathematical Electricity and Magnetism. *Tu, Th, F,* at 8. Professor PATTERSON.

Course 7 must be preceded by Course 2. A knowledge of calculus is also required.

8. Heat. Laboratory Work. *Twice a week. Hours to be arranged with instructor.* Dr. GUTHE.

Course 8 must be preceded by Course 2.

9. Theory of Heat: Preston. *Twice a week.* Professor CARHART.

SECOND SEMESTER.

1. Mechanics, Sound, and Light. Lectures *M, W, F,* at 11. Recitations *twice a week.* Assistant Professor REED.

Course 1 is open to those who have passed an entrance examination in physics, and to all others who have sufficient preparation. A knowledge of plane trigonometry is indispensable.

3. Physical Laboratory Work for Beginners. Repetition of Course 3, first semester. This course may be elected as—

3*a*. Sec. I. *M, W, F,* 9–11. Sec. II. *M, W, F,* 2–4.

3*b*. Sec. III. *Tu, Th,* 9–11. Professor PATTERSON and Dr. GUTHE.

3*c*. Laboratory work in Mechanical and Electrical Measurements. *Three times a week. Hours to be arranged.* Dr. GUTHE and Mr. JONES.

This course is designed for Engineering students who desire to elect Dynamo-Electric Machinery.

10. Mathematical Electricity and Magnetism. *Twice a week.* Professor PATTERSON.

Course 10 must be preceded by Course 7.

16. Chemical Physics. Electrochemistry. Theories of Solutions and Electrolytes, including the Osmotic Theory of the Voltaic Cell. Lectures, *twice a week.* Laboratory work, *once a week.* Dr. GUTHE.

Course 16 must be preceded by Course 2 in Electrical Engineering and Courses 1 and 4 in general chemistry.

CHEMISTRY.

FIRST SEMESTER.

1. Elementary Inorganic Chemistry, Descriptive and Experimental. Lectures and recitations, *M, W, F,* at 1. Lower Lecture Room, Medical Building. Mr. HIGLEY.

EITHER FIRST OR SECOND SEMESTER.

2. Laboratory Work in General Inorganic Chemistry. *Three or more hours. Any morning or afternoon. between* 9 *and* 12, *and* 1 *and* 4. Mr. HIGLEY, Mr. LICHTY, and Dr. SHERMAN.

Course 2 must be preceded or accompanied by Course 1 or an equivalent. It is supplementary to Course 1 and covers in the laboratory the ground covered by lectures in Course 1. Students should elect at least five hours of laboratory work in Course 2 during the year, in order to complete the beginning work in inorganic chemistry. Those wishing to distribute five hours of work through two semesters, may elect three hours in their first and two hours in their second semester.

3. Qualitative Analysis. *Five hours.* Recitations, *Tu, Th,* at 9; laboratory work, *three times a week.* Professor JOHNSON.

METALLURGY.

FIRST SEMESTER.

2. Micro-Metallography. The study of the microscopic structure of metals as related to their physical and chemical properties. Laboratory work with reading. *One hour.* Professor E. D. CAMPBELL.

Course 2 can be taken only by those who have taken Course 1 in metallurgy, and have received special permission.

1. Fuel and Refractory Material, Iron and Steel. *M, W, F*, at 10. Room B, Chemical Laboratory. Professor E. D. CAMPBELL.

   Course 1 must be preceded by Course 1 or Course 3 in analytical chemistry, or by Course 1 in general chemistry.

ASTRONOMY.

A knowledge of calculus is required for all courses in astronomy except 1, 2, 3, 10 and 12.

FIRST SEMESTER.

1. General Astronomy. *M, W. F*, at 11. Room 22, U. H. Professor HALL and Mr. TOWNLEY.
3. Spherical Astronomy. Elementary course, with exercises in computing. *Two hours.* Room 22, U. H. Professor HALL.

   Course 3 is introductory to Courses 5 and 8. It is also recommended to precede Course 4.
5. Spherical Astronomy. *Three hours.* Room 22, U. H. Mr. TOWNLEY.

   In Courses 5 and 8 some standard work on spherical astronomy will be read rapidly and special subjects will be given out for discussion.
6. Theory and Computation of Orbits, Gauss's Theoria Motus. *Five hours.* Room 22, U. H. Professor HALL.

EITHER FIRST OR SECOND SEMESTER.

2. Elementary Practical Course. *One hour.* Observatory. Mr. TOWNLEY.

   Course 2 is a continuation of Course 1.
4. Practical Astronomy. Use of sextant and transit. *Three hours.* Observatory. Mr. TOWNLEY.
9. Extended Practical Course. *Hours and credit arranged with instructors.* Observatory. Professor HALL and Mr. TOWNLEY.

SECOND SEMESTER.

7. Theory and Computation of Special Perturbations. *Three hours.* Room 22. U. H. Mr. TOWNLEY.
8. Spherical Astronomy. Continuation of Course 5. *Three hours.* Room 22, U. H. Professor Hall.
10. Lectures on Recent Progress in Astrophysical Astronomy. *One hour.* Room 22, U. H. Mr. TOWNLEY.
11. Mathematical Theory of Planetary Motion. *Three hours.* Room 22, U. H. Professor HALL.

12. History of Astronomy. *Two hours.* Room 22, U. H. Mr. TOWNLEY.
13. Theory of Least Squares. *Two hours.* Room 22, U. H. Professor HALL.

MINERALOGY.

FIRST SEMESTER.

1. Short Course. Lectures and practice. *Two hours.* Lectures, *Tu*, *Th*, at 9; practice, *twice a week, at hours arranged with instructor.* Room 6, T. H. Professor PETTEE.

For Course 1 an elementary knowledge of chemistry is desirable, though not required. A second lecture section, at 10, may be organized, if the demand is sufficient.

SECOND SEMESTER.

1. Short Course. Lectures and practice. *Two hours.* Lectures, *Tu*, *Th*, at 3; practice, *twice a week, at hours arranged with instructor.* Room 6, T. H. Professor PETTEE.

For Course 1 an elementary knowledge of chemistry is desirable, though not required.

DRAWING.

All the work in drawing is given in the Engineering Building.

In Courses 7 and 8, attendance in the drawing room on the days indicated is required for *one hour* in addition to the hour specified, and the hours of attendance should be consecutive, if possible.

FIRST SEMESTER.

1. Geometrical Drawing. *Two hours.* Sec, I, *M*, *W*, 10–12; Sec. II, *Tu*, *Th*, 10–12; Sec. III, *Tu*, *Th*, 8–10; Sec. IV, *M*, *W*, 1–3. Room 9. Mr. GOULDING.
4. Free-Hand Drawing. Pen and Ink, Pencil Work, Sketching. *Three hours.* Sec, I, *Tu*, *Th*, *F*, 10–12. Room 12. Professor DENISON. Sec. II, *M*, *W*, *F*, 1–3. Room 12. Mr. WRENTMORE. Sec. III, *M*, *W*, *F*, 8–10. Room 14. Mr. WRENTMORE. Sec. IV, *Tu*, *Th*, *F*, 8–10. Professor DENISON and Miss HUNT.

Sections II and III are more especially for mechanical and electrical engineering students.

10. Continuation of Course 8. *Twice a week,* 10–12. Room 12. Professor DENISON and Miss HUNT.

Course 10 must be preceded by Courses 4 and 8.

In Course 10 the section is limited in number.

13. Water Color Drawing. *Three hours. Hours arranged with instructor.* Room 12. Professor DENISON or Miss HUNT.

Course 13 must be preceded by Course 8. It is to be taken only by special permission.

SECOND SEMESTER.

5. Descriptive Geometry. *Four hours.* Sec. I, *M, Tu, Th,* at 9; *W,* 8–10. Room 3. Sec. II, *M, Tu, Th,* at 9; *F,* 9–11. Room 10; Sec. III, *M, Tu, Th,* at 8; *F,* 8–10. Room 3. Sec. IV, *M, Tu, F,* at 3; *Th,* 2–4. Room 3. Sec. V, *M, Tu, W,* at 8; *Th,* 9–11. Room 10. Professor DENISON, Mr. WRENTMORE and Mr. GOULDING.
6. Shades, Shadows, and Perspective. *Three hours. M, W, F,* at 9, *and such additional time as may be found necessary to complete the work.* Room 10. Professor DENISON.

Course 6 must be preceded by Course 5.

7. Free-Hand Drawing (advanced). *M, W, F,* at 10 or 11. Room 12. Professor DENISON or Miss HUNT.

In Course 7 the section is limited in number.

8. Architectural and Water-Color Drawing. *Tu, Th,* at 10 or 11. Room 12. Professor DENISON or Miss HUNT.

Course 8 must be preceded by Course 1 or 4. The section is limited in number.

14. Stereotomy. *Two hours. Tu, Th,* at 9, *and such additional time as may be found necessary to complete the work.* Room 10. Professor DENISON.

Course 14 must be preceded by Course 5.

16. Free-Hand Lettering. *Two hours. Tu, Th,* 10–12. Room 14. Mr. WRENTMORE.

Course 16 must be preceded by Course 1.

17. Spherical Projections. *One hour. Hour to be arranged with instructor.* Professor DENISON.

Course 17 must be preceded by Courses 1 and 5.

SHOP PRACTICE.

All Courses in Shop Practice are under the direction of Superintendent C. G. TAYLOR. Lectures on materials and appliances used in shopwork will be given in each of the courses, by the superintendent, Monday of each week, at 4 P. M. In some cases reading is assigned in place of lectures.

Courses 1*a*, 2*a*, 3*a*, and 4*a* may also be continued by advanced students, and elected as 1*b*, 2*b*, 3*b*, and 4*b*.

It is necessary for students to register promptly at the Superintendent's office on the first day of each semester to secure an assignment to a section.

Fee for each course, $5.00.

Special arrangements will be made for students who desire to take more advanced work in the shop courses with a view to preparing themselves for teaching these subjects.

EITHER FIRST OR SECOND SEMESTER.

1*a*. Shop Practice. Wood work and pattern work. Three sections. *Three hours.* Mr. Purfield and Supt. C. G. Taylor.

2*a*. Shop Practice in Forging. Five sections. *Two hours.* Mr. —— and Supt. G. C. Taylor.

3*a*. Shop Practice in Foundry Work. Three sections. *Two hours.* Mr. Winslow and Supt. C. G. Taylor.

4*a*. Shop Practice in Iron Work. Three sections. *Three hours.* Mr. Smoots and Supt. C. G. Taylor.

FIRST SEMESTER.

1*a*. Shop Practice. Sec. I, *M, Th,* 1–4; Sec. II, *Tu, F,* 1–4; Sec. III, *W, S,* 8–11, or *W,* 1–4, *S,* 8–11.

2*a*. Shop Practice. Sec. I, *M, W,* 1–3; Sec. II, *F,* 1–3, *S,* 8–10; Sec. III, *Tu, Th,* 1–3; Sec. IV, *M, F,* 10–12; Sec. V, *W, S,* 10–12.

SECOND SEMESTER.

1*a*. Shop Practice. Sec. I, *M, W,* 1–4; Sec. II, *Tu, Th,* 1–4; Sec. III, *W, S,* 8–11.

2*a*. Shop Practice. Sec. I, *W, S,* 8–10; Sec. II, *Tu, Th,* 1–3; Sec. III, *Th, S,* 10–12; Sec. IV, *M, Th,* 8–10; Sec. V, *Tu, F,* 8–10.

SURVEYING.

All the work in surveying is given in the Engineering Building.

FIRST SEMESTER.

1. Lectures and Field Practice with Instruments. *Four hours.* *Tu, W, Th, F,* 1–4. Room 5. Professor J. B. Davis.

The field practice in Course 1 continues during favorable weather until Christmas.

4. Use of Instruments. *One hour.* Room 5. Professor J. B. Davis.

6. Continuation of Course 5. Photo-topography. Field work and drawing, *one hour.* *M,* 1–4. Room 4. Professor J. B. Davis.

The ability to make photographic negatives will be of service.

SECOND SEMESTER.

2. Continuation of Course 1. Lectures and text-book, *five hours.* *M, Tu, W, Th, F,* at 9. Room 5. Professor J. B. Davis.

Course 2 must be preceded by Course 1.

3. Field Work in Camp. *Four weeks, six days each week,* 8–12 *and* 1–5. Professor J. B. DAVIS.

   Course 3 must be preceded by Courses 1 and 2 in surveying.

   Except by special permission Course 3 is open only to students who are working for a degree in civil engineering.

5. Topography. Transit and Stadia. Plane Table. Field work and drawing, *three hours. Thirteen weeks, M, Tu, W, Th,* 1–4. Rooms 5 and 9. Professor J. B. DAVIS.

   Course 5 must be counted as four times a week in making up elections.

7. Geodesy. Geodetic Methods. Lectures and text-book, *three hours. Twelve weeks, M, Tu, W, Th, F,* at 10. Room 5. Professor J. B. DAVIS.

   Course 7 must be counted as five times a week in making up elections, and must be preceded by Courses 1 and 2 in surveying.

CIVIL ENGINEERING.

The work in civil engineering is conducted in the Engineering Building.

FIRST SEMESTER.

1. Municipal Engineering. Lectures and text-book, *five hours. M, Tu, W, Th, F,* at 8. Room 5. Professor J. B. DAVIS.

4. Graphical Analysis of Structures. *Tu, Th,* at 9. Room 4. Professor GREENE.

   Course 4 must be preceded by Course 3.

5. Strength and Resistance of Materials. *M, W,* Sec. I, at 9; Sec. II, at 10. Room 4. Professor GREENE.

   Sec. I is for students in civil engineering. Sec. II, for others.

   Course 5 must be preceded by Course 6 in mathematics.

6. Engineering. Theory of construction, *F,* at 9. Room 4. Professor GREENE.

   Course 6 must be preceded by Course 6 in mathematics.

7. Engineering Design. *Five hours. M, Tu, W, Th, F,* 1–4 or 2–5. Room 14. Professor GREENE.

   Course 7 accompanies Courses 5 and 6.

SECOND SEMESTER.

2. Tests of Materials. *One hour. S,* 9–12. Engineering Laboratory. Professor GREENE.

3. Graphical Analysis of Structures. Sec. I, *M, W,* at 10; Sec. II, *Tu, Th,* at 10. Room 4. Professor GREENE.

   Sec. II is for students in civil engineering; Sec. I, for others.

   Course 3 requires at least a limited knowledge of statics.

8. Engineering. Theory of construction, *M, Tu, Th, F,* at 9. Room 4. Professor GREENE.

9. Hydraulics. *W,* at 9. Room 4. Professor GREENE.

10. Water Supply and Sewerage. *F,* at 10. Room 4. Professor GREENE.

MECHANICAL ENGINEERING.

The work in mechanical engineering is conducted in the Engineering Building, unless otherwise noted.

Students beyond the first year will elect courses by the numbers in parentheses.

FIRST SEMESTER.

2a. (5*a*). Principles of Mechanism. Valve Gears. *Three hours. Tu, Th,* 9–11, *and additional time arranged with instructor.* Room 10. Professor DENISON.

In 1899–1900 Course 2*a* will be extended to *four hours.*

Course 5*a* is for students in mechanical and electrical engineering, and must be preceded by Course 1 or 1*a* in mathematics, and by Courses 1 and 5 in drawing.

2b. (5*b*.) Principles of Mechanism. *Two hours. Tu, Th,* 9–11. Room 12. Professor DENISON.

Course 5*b* is for students in civil engineering, and must be preceded by Course 1, or 1*a*, in mathematics, and by Courses 1 and 5 in drawing.

15. (8*a*.) Prime Movers. Water wheels and steam engines, *Tu, Th,* at 10. Room 7. Professor COOLEY and Mr. ALLEN.

5. (8*b*.) Hydraulic Machinery. *Tu,* at 10. Room 7. Professor COOLEY.

In 1899–1900 Course 5 will be extended to *two hours.*

Course 5 is intended for those who have taken Course 4; and Course 15 is intended for all others.

Courses 15 and 5 must be preceded by Course 3*a* or 3*b*.

8. (10.) Theory of Machine Design. *W, F,* at 11. Room 7. Professor COOLEY.

In 1899–1900 Course 8 will be extended to *three hours.*

Course 8 must be preceded or accompanied by Course 5 in civil engineering.

7. (12.) Thermodynamics. Hot air and gas engines, air compressors, and refrigerating machines, *Tu, Th,* at 9. Room 7. Mr. ALLEN.

Course 7 must be preceded by Course 3 and by Courses 1 and 2 in physics.

[13. Steam Engines. Advanced course. Gas engines. *Three hours.* Professor COOLEY.

Course 13 will not be given in 1897–98.]

16. (15.) Heating and Ventilation. Gas engines. *Two hours. Tu, Th,* at 11. Room 7. Professor COOLEY.

Course 16 must be preceded or accompanied by Course 15 or 4.

EITHER FIRST OR SECOND SEMESTER.

6. (6*a*.) Machine Design. Machine tools. *Two hours.* First semester. *Tu, Th,* 9–12. Second semester, Sec. I, *Tu, Th,* 9–12; Sec. II. *W, F,* 9–12. Drawing Room, Engineering Laboratory. Superintendent C. G. TAYLOR.

Course 6*a* must be preceded by Courses 1, 5, and 9 in drawing, and preceded or accompanied by Course 2 in mechanical engineering.

9. (17.) Laboratory Work. Power measurements. Machine testing. *Two hours. Tu, Th,* 1–4. Professor COOLEY and Mr. ALLEN. Fee $2.

Course 9 must be preceded by Courses 3*a* or 3*b*.

10. (11.) Machine Design. Hoisting machinery. *Three hours. M, W, F,* 1–4. Engineering Laboratory. Professor COOLEY and Mr. FAIG.

Course 10 must be preceded or accompanied by Course 8.

11. (16.) Laboratory Work. Steam engineering. *Three hours.* Sec. I, *M, W, F,* 1–4. Sec. II, *hours to be arranged.* Professor COOLEY, Mr. ALLEN, and Mr. JONES. Fee $3.

Course 11 must be preceded by Course 4, 5 or 15.

12. (14.) Machine Design. Boilers and engines. *Two hours. Tu, Th,* 1–4. Engineering Laboratory. Professor COOLEY and Mr. FAIG.

Course 12 must be preceded or accompanied by Course 8.

It is suggested that Courses 9 and 10 and Courses 11 and 12 be taken in pairs.

SECOND SEMESTER.

[1. Elements of Machines. Nomenclature. *Two hours.* Mr. FAIG.

Course 1 will not be given in 1897–98.]

3*a*. (7*a*.) Dynamics of Machinery. *M, W,* Sec. I, at 8; Sec. II, at 10. Room 7. Mr. FAIG.

3*b*. (7*b*.) Dynamics of Machinery. *One hour. First half of semester. M, W,* Sec. I, at 8; Sec. II, at 10. Room 7. Mr. FAIG.

Course 3*b* is the same as the first half of Course 3*a*, and is intended for students in civil engineering.

Courses 3*a* and 3*b* must be preceded by Course 6 in mathematics, and by Course 1 in physics.

4. (9.) Boilers. Steam engines. Valve gears. *M, W, F,* at 9. Room 7. Mr. ALLEN.

Course 4 must be preceded or accompanied by Course 3*a* or 3*b*.

14. (13.) Power Plants. Power transmission. Specifications and contracts. *Tu, Th,* at 10. Room 7. Professor COOLEY.

Course 14 must be preceded by Course 5 or 15.

17. (18.) Compressed Air Machinery. Mechanical refrigeration. *M, F,* at 8. Professor COOLEY.

Course 17 must be preceded by Course 7.

ELECTRICAL ENGINEERING.

The courses in Electrical Engineering are given in the Physical Laboratory. Courses 1, 2, 4*a*, 5, (formerly 4, 5, 8*a*, and 13), 6 (formerly 9 and 14), 7 and 8 are required of candidates for the degree in electrical engineering. Course 3 will also be required of those entering in 1897 and thereafter.

FIRST SEMESTER.

2. Electrical measurements: Carhart and Patterson's Electrical Measurements. *Four hours.* Recitations, *F,* at 3. Assistant Professor PATTERSON. Laboratory work *three times a week*, 8–10, 10–12 or 1–3. Assistant Professor PATTERSON, Dr. GUTHE, and Mr. JONES. Fee $3.

Course 2 must be preceded by Courses 1, 2 and 3 in physics; a knowledge of calculus is also required.

5. Alternate Current Apparatus. *Three hours.* Recitations, *M, W,* at 8. Laboratory work, *once a week.* Professor CARHART and Mr. JONES. Fee $1.

Course 5 must be preceded by Course 4.

6. Photometry of Electric Lamps: Palaz's Photometry. *One hour.* Recitations *once a week* for first eight weeks; laboratory work *once a week* for last eight weeks. Assistant Professor PATTERSON. Fee $1.

7. Design of Electrical Machinery and Appliances. Lectures *two hours;* drawing, *two hours.* Professor CARHART and Mr. JONES.

Course 7 must be preceded by Course 4.

SECOND SEMESTER.

1. Primary and Secondary Batteries: Carhart's Primary Batteries. *Two hours.* Recitation, *F,* at 8. Laboratory work *once a week.* Dr. GUTHE. Fee $1.

Course 1 must be preceded by Courses 1, 2 and 3, in physics, and a Course in general or in analytical chemistry.

3. Electrical Measurements: Continuation of Course 2. *Three hours.* Lecture, *once a week.* Laboratory work, *twice a week.* Dr. GUTHE and Mr. JONES. Fee $2.

4*a*. Dynamo-Electric Machinery: Thompson's Dynamo-Electric Machinery. *Four hours.* Lectures and recitations, *Tu*, *Th*, at 8. Professor CARHART. Laboratory work, *twice a week.* Professor CARHART and Mr. JONES. Fee, $2.

4*b*. *Three hours.* Recitations and lectures as above. Laboratory work, *once a week.* Fee $1.

Course 4*a* must be preceded by Course 2 in electrical engineering and 4*b* by Course 3*c* in physics.

8. Distribution of Electricity. *Two hours.* Lectures and recitations. Assistant Professor PATTERSON and Mr. JONES.

Course 8 must be preceded by Course 4.

MARINE ENGINEERING.

Course 2 is designed for graduate students and undergraduates who have had the necessary preliminary training. Courses 1 and 3 are for graduates.

FIRST SEMESTER.

1. Naval Architecture.

SECOND SEMESTER.

2. Marine Engines. *M*, *Tu*, *Th*, at 9. Room 11. Professor COOLEY.
3. Ship-Building.

SCHEDULE OF EXAMINATIONS.

Time of Exercise.*	Monday 8	Monday 9	Monday 10	Monday 11	Monday 1	Monday 2	Monday 3
Time of Examination.	Monday 8-10	Tuesday 8-10	Thursday 8-10	Friday 8-10	Thursday 4-6	Tuesday 2-4	Wednesday 2-4
Time of Exercise.	Tuesday 8	Tuesday 9	Tuesday 10	Tuesday 11	Tuesday 1	Tuesday 2	Tuesday 3
Time of Examination.	Saturday 8-10	Wednesday 8-10	Monday 2-4	Thursday 2-4	Friday 4-6	Saturday 4-6	Friday 2-4
Time of Exercise.	Wednesday 8	Wednesday 9	Wednesday 10	Wednesday 11	Wednesday 1	Wednesday 2	Wednesday 3
Time of Examination.	Saturday 10-12	Monday 10-12	Friday 10-12	Wednesday 10-12	Monday 4-6	Tuesday 10-12	Thursday 10-12

*NOTE: By the **Time of Exercise** is meant the time of the first Exercise of the week in any given Course. For example: If a Course is given Monday at 3, Wednesday at 3, and Friday at 10, it is said to be given **Monday at 3.** By referring to Monday 3, in the Schedule, it will be seen that the examination falls upon Wednesday 2–4. In Courses not provided for, the examinations will be held at hours arranged so as not to conflict with the schedule.

UNIVERSITY OF MICHIGAN

Department of Engineering

GENERAL ANNOUNCEMENT

FOR

1898-99

ANN ARBOR, MICHIGAN
PUBLISHED BY THE UNIVERSITY
1898

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Department of Engineering

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ANNOUNCEMENTS FOR 1898–99.

1898.	
June 28.	Class Day.
June 29.	Alumni Day.
June 30.	Commencement in all Departments of the University.
July 1 to Sept. 26.	Summer Vacation.
July 6 to Aug. 18.	Summer School.
Sept. 22 to 24.	*Examination for Admission to the Department of Engineering.*
Sept. 27.	FIRST SEMESTER BEGINS IN ALL DEPARTMENTS OF THE UNIVERSITY.
Nov. —.	Thanksgiving Recess of three days, beginning Tuesday evening, in all Departments of the University.
Dec. 22.	(Evening.) Holiday Vacation begins in all Departments.
1899.	
Jan. 10.	Exercises resumed.
Feb. 10.	(Evening.) FIRST SEMESTER CLOSES.
Feb. 13.	SECOND SEMESTER BEGINS.
April 14.	(Evening.) Recess begins, ending April 24 (Evening).
June 22.	COMMENCEMENT IN ALL DEPARTMENTS OF THE UNIVERSITY.

THE COURIER PRINT.
ANN ARBOR, MICH.

Department of Engineering.

FACULTY.*

†JAMES B. ANGELL, LL.D., PRESIDENT.

CHARLES E. GREENE, A.M., C.E., Professor of Civil Engineering, and Dean of the Department of Engineering.

WILLIAM H. PETTEE, A.M., Professor of Mineralogy, Economic Geology, and Mining Engineering.

EDWARD L. WALTER, PH.D., Professor of Romance Languages and Literatures.

ISAAC N. DEMMON, LL.D., Professor of English and Rhetoric.

MORTIMER E. COOLEY, M.E., Professor of Mechanical Engineering.

WOOSTER W. BEMAN, A.M., Professor of Mathematics.

CHARLES S. DENISON, M.S., C.E., Professor of Descriptive Geometry, Stereotomy and Drawing.

HENRY S. CARHART, LL.D., Professor of Physics, and Director of the Physical Laboratory.

RAYMOND C. DAVIS, A.M., Librarian.

OTIS C. JOHNSON, PH.C., A.M., Professor of Applied Chemistry.

PAUL C. FREER, PH.D., M.D., Professor of General Chemistry, and Director of the Laboratory of General Chemistry.

JOSEPH B. DAVIS, C.E., Professor of Geodesy and Surveying.

ASAPH HALL, JR., PH.D., Professor of Astronomy, and Director of the Observatory.

ISRAEL C. RUSSELL, C.E., LL.D., Professor of Geology.

GEORGE A. HENCH, PH.D., Professor of Germanic Languages and Literatures.

CLARENCE G. TAYLOR, B.S., M.E., Professor of Mechanical Practice, and Superintendent of Shops.

GEORGE HEMPL, PH.D., Junior Professor of English.

EDWARD D. CAMPBELL, B.S., Junior Professor of Analytical Chemistry.

FRED N. SCOTT, PH.D., Junior Professor of Rhetoric.

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* In this list are included a few other officers and instructors with whom engineering students are likely to elect work.

† Absent on leave. During President Angell's absence Professor Harry B. Hutchins performs the duties of President.

ALEXANDER ZIWET, C.E., Junior Professor of Mathematics.
GEORGE W. PATTERSON, Jr., A.M., S.B., Junior Professor of Physics.
PAUL R. de PONT, A.B., B.S., Assistant Professor of French, and Registrar of the Department of Engineering.
JOHN O. REED, Ph.D., Assistant Professor of Physics.
JOSEPH L. MARKLEY, Ph.D., Assistant Professor of Mathematics.
ELMER A. LYMAN, A.B., Instructor in Mathematics.
GEORGE O. HIGLEY, M.S., Instructor in General Chemistry.
DAVID M. LICHTY, M.S., Instructor in General Chemistry.
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EDWIN C. GODDARD, Ph.B., Instructor in Mathematics.
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JOHN T. FAIG, M.E., Instructor in Mechanical Engineering.
SIDNEY D. TOWNLEY, Sc.D., Instructor in Astronomy.
ALFRED H. WHITE, A.B., Instructor in Chemical Technology.
CARROLL D. JONES, B.S., E.E., Instructor in Electrical Engineering.
EDGAR E. BRANDON, A.M., Instructor in French.
JOHN E. LAUTNER, M.L., Instructor in German.
ALICE L. HUNT, Assistant in Drawing.
CHARLES H. GRAY, M.L., Assistant in English.
GRANT H. DUNNING, B.S., Assistant to the Dean of the Department of Engineering.

Special Assistants in the Engineering Shops.

ROBERT A. WINSLOW, Foundry.
JOHN M. SMOOTS, Iron Room.
HORACE T. PURFIELD, Wood and Pattern Room.
WILLIAM R. McDONALD, Forge Shop.

Department of Engineering.

GENERAL INFORMATION.

THE University of Michigan is a part of the educational system of the State, and derives from the State, in one way or another, the greater part of its revenue. The University comprises the Department of Literature, Science, and the Arts, and six professional schools, each of which has its own Faculty and issues each year a separate departmental announcement. The various faculties aggregated in 1897–8 one hundred and fifty officers of instruction, besides numerous assistants, some of whom participate in the work of teaching. About thirty-two hundred students, representing forty-seven States and Territories, and fifteen foreign countries, were in attendance.

In the legislative act under which the University was organized in 1837, provision was made for instruction in engineering. Work was begun in this line in 1853, and the first degrees were conferred in 1860. The engineering courses were included in the Department of Literature, Science, and the Arts, until the close of the college year, 1894–95. At that time the Department of Engineering was established by the Board of Regents.

Persons who wish to become professional engineers are offered here thorough courses of study in civil, mechanical, and electrical engineering. The work extends through four years. The aim of the Department is to lay a foundation of sound theory, sufficiently broad and deep to enable its graduates to enter understandingly on the further investigation of the several specialties of the profession; and at

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Beginning in September, 1898, the academic year will extend from the Tuesday preceding the last Wednesday in September to the Thursday preceding the last Wednesday in June.

REQUIREMENTS FOR ADMISSION TO THE DEPARTMENT OF ENGINEERING.

[For admission to advanced standing, see page 10.].

[For admission of students not candidates for a degree, see page 11.]

Candidates for admission must be at least sixteen years of age, and must present satisfactory evidence of good moral character. They must bring credentials from their last instructor, or from the last institution with which they have been connected.

Unless admitted on diploma from an approved school (see page 13), any student who desires to become a candidate for a degree must pass examinations in the subjects described below. Before entering upon the examination each applicant must present his credentials to the Dean of the Department at his office in the Engineering Building. Certificates and diplomas from schools other than those officially examined by the University, as specified on page

14, will not excuse an applicant from admission examinations.

Students who have satisfied any one of the four groups of requirements for admission to the Department of Literature, Science, and the Arts will be admitted upon completing the requirements in Plane Trigonometry and in Chemistry. (See page 9.)

Admission of Candidates for a Degree.

The subjects on which applicants for admission to any of the courses leading to a degree in engineering will be examined are as follows:

English Language.—*Grammar.*—Selections for analysis and parsing will be set, arranged to test the applicant's knowledge of the leading facts of English Grammar. To meet this requirement, a review of the subject should be had during the last year of the preparatory course.

Composition and Rhetoric.—The purpose of the examination in composition is to test the applicant's ability to write good English. To this end he will be asked to write two essays of not less than two hundred words each, one upon a subject drawn from books he has read, and the other upon a subject drawn from his experience or observation. The language of these essays must be grammatical and clear. The spelling, punctuation, and capitalizing must be correct. The applicant must show ability to discriminate in the use of words and to construct well-organized sentences and paragraphs. A topical outline should accompany each essay.

As preparation for this requirement, sustained and regular practice in writing is earnestly recommended. The student should prepare numerous written exercises throughout the four years of the high-school course, and a sufficient number of these exercises should be corrected by the teacher and revised by the student to secure the desired accuracy. The subjects upon which the student writes should not be drawn exclusively from literature; a considerable proportion of them should be taken from the student's every-day experience; and topics should be so distributed as to give proper training in the various types of discourse, namely, description, narrative, argument, and exposition. The student should be grounded in the essentials of rhetoric, but those principles should receive emphasis which are most likely to be of service to him in his practice in writing, such as the principles of sentential structure, paragraphing, and the outlining of the essay. The correction of stock specimens of bad English is not recommended, and will form no part of the entrance requirement.

It is further recommended that the reading of English classics and the memorizing of notable passages, both in prose and poetry, should form a regular exercise throughout the whole preparatory period. This is all-important for the development of a correct taste in language and literature.

The books, from which subjects for compositions will be chosen in the years named, are here given. The applicant should make himself familiar with the plot, incidents, and character of each work. Equivalents will be accepted.

1898. Milton's *Paradise Lost*, Books I and II; Pope's *Iliad*, Books I and XXII; Goldsmith's *The Vicar of Wakefield;* Southey's *Life of Nelson;* Lowell's *The Vision of Sir Launfal;* Hawthorne's *The House of Seven Gables.*

1899. Chaucer's *The Knight's Tale*, or Dryden's *Palamon and Arcite;* Milton's *Paradise Lost*, Books I and II; Pope's *Iliad*, Books I, VI, XXII, and XXIV; The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* DeQuincey's *Revolt of the Tartars;* Cooper's *The Last of the Mohicans;* Lowell's *The Vision of Sir Launfal;* Hawthorne's *The House of Seven Gables.*

1900. Chaucer's *The Knight's Tale*, or Dryden's *Palamon and Arcite;* Milton's *Paradise Lost*, Books I and II; Pope's *Iliad*, Books I, VI, XXII, and XXIV; The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* De Quincey's *Revolt of the Tartars;* Cooper's *The Last of the Mohicans;* Macaulay's *Essay on Milton;* Burke's *Conciliation with the Colonies.*

1901. Shakespeare's *Merchant of Venice* and *Macbeth;* Milton's *Lycidas, Comus, L'Allegro, and Il Penseroso;* Burke's *Conciliation with the Colonies;* Macaulay's *Essays on Milton and Addison;* Pope's *Iliad*, Books I, VI, XXII, and XXIV; The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Coleridge's *The Ancient Mariner;* Scott's *Ivanhoe;* Cooper's *The Last of the Mohicans;* Tennyson's *The Princess;* Lowell's *The Vision of Sir Launfal*; George Eliot's *Silas Marner.*

English Literary History.—In addition to the books just named, it is expected that several other English Classics will be read each year. These readings should be connected, in reasonable measure, with the lives and characters of the authors read and with the history of their times. A good knowledge of the chronological order and of the leading characteristics of the principal modern English writers should be aimed at. Care should be taken not to overload the text of these classics with a mass of irrelevant and petty learning. Many of the "school classics" now in use are over-edited.

English Literature.—Daily recitations for at least one year will be requisite. Stopford A. Brooke's English Literature (edition of 1896), or any other manual, may be used for an outline of the subject. As much time as practicable should be given to the careful reading of representative authors in each period.

French, German, or Latin.—Applicants may offer French, German, or Latin, one of these three languages being required. It is expected that at least two years will be given to preparation in the language offered. The requirements in each are as follows:

French.—The whole subject of French Grammar. The applicant will be expected to read at sight easy French, and to translate correctly into French simple English sentences. The first year ought to be spent on the grammar and easy reading, and the second devoted to reading good modern French, accompanied by grammatical analysis and exercises in writing. The texts read should be chiefly narrative and conversational prose; modern, rather than classic, dramas should be read.

German.—(1) Ability to pronounce German correctly and to take part with reasonable correctness and facility in a simple conversation upon some topic drawn from the applicant's preparatory work. (2) Thorough familiarity with the every-day facts of the grammar, to be evidenced by putting illustrative English phrases into German. (3) Ability to translate at sight a passage of moderately difficult prose.

Advanced credit may be secured for one or two years of German or French study in excess of the two years required for admission.

Latin.—Jones's First Latin Book, or an equivalent amount in any other introductory text-book, four books of Caesar's Gallic War, and one of the orations of Cicero.

Mathematics.*—*Algebra.*—Fundamental Rules, Fractions, Simple Equations, Involution and Evolution, the Calculus of Radicals, and Quadratic Equations, as given in Olney's Complete School Algebra, or an equivalent in other authors.

Geometry.—Plane, Solid, and Spherical Geometry as given in Beman and Smith's Plane and Solid Geometry, or an equivalent in other authors.

Trigonometry.—Plane Trigonometry as given in Olney's Elements of Trigonometry, or an equivalent in other authors.

N. B.—It is very desirable that High Schools whose graduates are received on diploma arrange their courses so as to include a portion of both algebra and geometry in their last preparatory year. Students who do not come from diploma schools should take a similar review if they expect to succeed in the study of mathematics in the University.

Physics.—An amount represented by Carhart and Chute's Elements of Physics. Laboratory work in physics is urgently advised, though not required; but students who have completed a course in laboratory practice, may expect to derive advantage from it if they take work in the physical laboratory in the University (see page 31).

Chemistry.—The requirement is intended to cover one year's work. As a text-book, Freer's Elementary Chemistry, or an equivalent amount of work in Remsen's Introduction to the Study of Chemistry, is recommended. In either case the text should be accompanied by laboratory work.

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*Students entering at the beginning of the second semester (February 13, 1899) should be prepared in the mathematics of the first semester in addition to the other requirements for admission.

History.—General History as presented in such a work as Myers's General History, and one year's work in United States History and Civil Government. Johnston's History of the United States and Fiske's Civil Government or Hinsdale's American Government are recommended as text-books.

Botany, Physical Geography, or Astronomy.—The applicant may offer any *one* of these subjects. The requirements, intended to cover a half-year's work in each subject, are as follows:

Botany.—Laboratory work for half a year with occasional recitations and review exercises. Spalding's Introduction to Botany, or Bergen's Elements of Botany, will indicate the kind of work desired.

Physical Geography.—Tarr's Elementary Physical Geography, especially chapters 9 to 21 inclusive, or an equivalent.

Astronomy.—Newcomb and Holden's Astronomy, Briefer Course, Young's Elements of Astronomy, or an equivalent. A knowledge of the principal constellations is required.

Admission to Advanced Standing.

1. Graduates of the Department of Literature, Science, and the Arts of this University, or of any other reputable college, are admitted without examination to advanced standing as candidates for a degree in engineering, and are excused from a considerable portion of the general requirements for graduation (see page 42). The remaining requirements can be completed in two years, or, possibly, in a single year, if the student has taken as electives, while an undergraduate, some of the courses open to him in the Department of Engineering. A knowledge of differential and integral calculus, of analytical mechanics, of elementary drawing, and of descriptive geometry, is needful for the advanced work.

2. Students who have completed at least one year's college work in an approved college, and who bring explicit and official certificates describing their course of study and scholarship, and testifying to their good character, will be admitted to advanced standing without examination, except

such as may be necessary to determine what credit they are to receive for work done in the college from which they have come.

3. Students who have not completed a year's college work in an approved college, but, previous to entering this department of the University, have pursued studies beyond those required for admission, may be admitted to advanced standing on passing the regular entrance examinations, and examinations in such undergraduate studies as they may ask to be credited with in advance.

4. Rules relating to admission to advanced standing:

a. All students, whether candidates for a degree or not, who apply for advanced standing on the conditions stated in paragraphs (2) and (3) above, must present to the Dean a statement showing the amount of work done in the subjects in which credit is asked.

b. The application for advanced standing should be made to the Dean immediately after matriculation; and the Dean will furnish a blank form for presentation to the professors in charge of the several subjects named in the blank.

c. Credits must be secured before the fifteenth of December or (if the student be matriculated after that date) before the tenth of April.

d. No credits will be given for advanced standing after the dates named in (*c*).

e. An account once closed cannot be reopened without special permission of the Faculty.

Admission of Students not Candidates for a Degree.

Persons who desire to pursue studies in this department, and do not desire to become candidates for a degree, are admitted on the following conditions:

1. All persons under twenty-one years of age must pass the regular entrance examinations.

2. Persons over twenty-one years of age must show that they have a good knowledge of English and are otherwise prepared to pursue profitably the studies they may desire to take up. Every applicant ought to have had the training received in a good high school.

3. Should a student who enters under the preceding provision (2) subsequently become a candidate for graduation, he must pass the regular entrance examinations, at least one year previous to the time when he proposes to graduate.

4. Students not candidates for a degree who wish credit for studies pursued before admission are referred to the rules relating to advanced standing given above.

5. Students not candidates for a degree are expected to attend the lectures, recitations, and examinations in the branches prescribed for the regular students, and are required to take enough work to occupy them profitably.

Time of Examination.

The examination for admission to the Department of Engineering will be held on Thursday, Friday, and Saturday, September 22, 23, and 24, 1898.* Applicants will not be examined at any other time except on payment of a special fee of *five dollars.*

As the examination begins at 8 A. M. on Thursday, it will be necessary for all applicants for admission on examination to present their credentials to the Dean of the Department, at his office, on Wednesday, September 21, between the hours of 9 and 5, and receive from him papers admitting to the examination.

The examination in the several subjects will be in writing and will be held in Tappan Hall in accordance with the schedule given below:

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* The practice of holding an admission examination in June has been discontinued.

THURSDAY, SEPTEMBER 22.

8 A. M.	Physics	Lecture Room
10 A. M.	History	Lecture Room
4 P. M.	Chemistry	Lecture Room

FRIDAY, SEPTEMBER 23.

8 A. M.	Geometry	Lecture Room
10 A. M.	Botany	Lecture Room
10 A. M.	Physical Geography	Lecture Room
10 A. M.	Astronomy	Lecture Room
2 P. M.	Latin	Lecture Room
2 P. M.	French	Room 12
2 P. M.	German	Room 10

SATURDAY, SEPTEMBER 24.

8 A. M.	Algebra	Lecture Room
8 A. M.	Trigonometry	Lecture Room
10 A. M.	English Literature	Room 10
2 P. M.	English	Lecture Room

Admission on Diploma.

Students presenting graduation certificates from any of the schools approved by the Faculty of the Department of Literature, Science, and the Arts, are admitted without further examination to the Department of Engineering. The certificate from the school superintendent or principal, stating that the student has sustained his examinations in all the studies prescribed for admission to the Department of Engineering, or to any one of the courses offered in the Department of Literature, Science, and the Arts, and is recommended for admission to the University, must be presented to the Dean of the Department within a year and three months after graduation from the school, and the student must then begin his work.

If a certificate which would admit a student to the Department of Literature, Science, and the Arts shows any deficiencies in the requirements for admission to the Department of Engineering, such deficiencies must be made up, or substitutions secured from the Dean; extra studies

2. Persons over twenty-one years of age must show that they have a good knowledge of English and are otherwise prepared to pursue profitably the studies they may desire to take up. Every applicant ought to have had the training received in a good high school.

3. Should a student who enters under the preceding provision (2) subsequently become a candidate for graduation, he must pass the regular entrance examinations, at least one year previous to the time when he proposes to graduate.

4. Students not candidates for a degree who wish credit for studies pursued before admission are referred to the rules relating to advanced standing given above.

5. Students not candidates for a degree are expected to attend the lectures, recitations, and examinations in the branches prescribed for the regular students, and are required to take enough work to occupy them profitably.

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If a certificate which would admit a student to the Department of Literature, Science, and the Arts shows any deficiencies in the requirements for admission to the Department of Engineering, such deficiencies must be made up, or substitutions secured from the Dean; extra studi may be credited on advanced standing, if the subjects are taught in either of the two departments.

The schools named below have been approved by the Faculty of the Department of Literature, Science, and the Arts as qualified to prepare students for admission on diploma.

Adrian; Albion; Allegan; Alpena; Ann Arbor; Ashburnham, Mass.: Cushing Academy; Aurora, Ill.: East Side, West Side; Austin, Ill.; Battle Creek; Bay City; Belding; Benton Harbor; Benton Harbor: Normal and Collegiate Institute; Big Rapids; Big Rapids: Ferris Industrial School; Birmingham; Bloomington, Ill.; Blue Island, Ill.; Buchanan; Cadillac; Calumet; Caro; Cassopolis; Cedar Rapids, Ia.; Champion; Charlotte; Cheyenne, Wyo.; Chicago, Ill.: English High and Manual Training School, Manual Training School, North Division, Northwest Division, South Division, West Division, Calumet, Englewood, Hyde Park, Jefferson High School, Lake, Lake View, South Chicago; Chicago, Ill.: Harvard School, Kenwood Institute, Princeton-Yale School; Chillicothe, O.; Cincinnati, O.: Hughes School; Cleveland, O.: Central High School; Clinton, Ia.; Clyde, Ill.; Coldwater; Constantine; Corunna; Decatur; Decatur, Ill.; Delafield, Wis.: St. John's Academy; Detroit; Detroit: Detroit School for Boys, Home and Day School; Dowagiac; Duluth, Minn.; Eaton Rapids; Elgin, Ill.; Elyria, O.; Erie, Pa.; Escanaba; Fenton; Flint; Geneseo, Ill.; Gladstone; Golden, Col.; Grand Haven; Grand Rapids; Greenville; Hancock; Harvey, Ill.; Hastings; Hillsdale; Holly; Houghton; Howell; Hudson: West Side; Indianapolis, Ind.; Indianapolis, Ind.: Classical School for Girls, Industrial Training School; Ionia; Iron Mountain; Ishpeming; Ithaca; Jackson: East Side, West Side; Joliet, Ill.; Jonesville; Kalamazoo; Kalamazoo: Michigan Female Seminary; Kankakee, Ill.; Kansas City, Mo.; Kendallville, Ind.; La Grange, Ill. (Lyons township); Lake Linden; Lansing; Lapeer; Laporte, Ind.; Leavenworth, Kan.; Ludington; McGregor, Ia.; Manistee; Mansfield, O.; Marine City; Marinette, Wis.; Marquette; Marshall; Mason; Maywood, Ill ; Menominee; Michigan City, Ind.; Midland; Moline, Ill.; Monroe; Mt. Clemens; Mt. Pleasant; Muskegon; Nashville; Negaunee; New York, N. Y.: Berkeley School; Niles; Norway; Oak Park, Ill.; Omaha, Neb.; Orchard Lake: Michigan Military Academy; Ottawa, Ill.; Owosso; Paw Paw; Peoria, Ill.; Petoskey; Plainwell; Pontiac; Port Huron; Portland; Rockford, Ill.; Saginaw: East Side, West Side; St. Clair; St. Johns; St. Joseph; St. Louis; St. Louis, Mo.: Smith Academy; Sault Ste. Marie; Schoolcraft; Sioux City, Ia.; South Bend, Ind.; Spring Arbor: Spring Arbor Seminary; Springfield, Ill.; Sturgis; Tacoma, Wash.; Taylorville, Ill.; Tecumseh; Three Rivers; Toledo, O.; Traverse City; Troy, O.; Union City; Vassar; West Bay City; West Des Moines, Ia.; Wyandotte; Ypsilanti.

THE WORK OF THE DEPARTMENT.

The studies pursued in the earlier part of the course comprise, in *Mathematics*, advanced algebra, analytic geometry, and the elements of differential and integral calculus; in *French* and *German*, an amount covering in all about a year and a half of study; in *English*, courses in higher English grammar and composition; in *Physics* and *Chemistry*, study of the principles; and in *Drawing*, practice in geometrical and in mechanical drawing, and in the study of descriptive geometry.

The more technical subjects are taken up in the latter part of the course. Some of these subjects are of equal value to all classes of engineering students, such as analytical and applied mechanics, the strength and resistance of materials, and the metallurgy of the useful metals, especially iron and steel; others are adapted more particularly to the wants of the special students in the several courses. Their general scope may be seen from the following descriptive outline.

DESCRIPTION OF COURSES.

Drawing.—A very complete course in mechanical drawing is given, embracing plane projection drawing, isometric drawing, descriptive geometry, and the elementary principles of coloring and shading, with original problems executed in the drawing room. Examples from numerical data are always given when suited to the conditions of the problem in hand. Students in mechanical engineering are required to sketch pieces of machinery, and afterwards to make working drawings suitable for use in the shop. The plans of surveys, plane-table work, maps, designs in engineering construction, and the thesis drawings naturally come under this head. Instruction is also given in free-hand drawing, topographical drawing, ornamentation and lettering, shades and shadows, linear perspective, and drawing for stone cutting. The work in drawing occupies the student a part of almost every day throughout the course.

There are four large and well-lighted drawing-rooms, three of which are in the engineering building and one in the engineering laboratory. There are also special rooms for blue-printing and a dark room for photography.

Mechanical Practice and Shop Work.—The aim of the instruction in this department is to make the student, as far as time will permit, acquainted with the best mechanical practice; the instructors in all practical work are men of wide experience, selected for their mechanical skill; and the department attempts to keep in touch with the most improved methods of mechanical construction.

The courses of instruction all begin with a systematic series of graded exercises, to give the student familiarity with the common tools used in the particular branch of work he is pursuing; and in connection with each course the theory of the process is taught by lectures or by assigned readings. The student thus becomes fitted to execute an ordinary piece of mechanical work and at the same time acquires a familiarity with sources of information bearing upon such work. At a later stage in the course the student is taught to apply the principles previously studied in the class room, and to combine skill and knowledge in the transformation of crude materials into articles which have a market value.

In *Wood Work and Pattern Making*, after the student has completed he preliminary series of graded exercises, he is set to making and assembling the parts of some complete piece of carpenter or joiner work, and he then devotes the remainder of the time, about three-fifths of the whole, to the pattern work. Special stress is laid upon this part of the course. The student shapes, forms, and builds up patterns for castings in iron, brass, etc.; allows for shrinkage; makes core boxes; and becomes as familiar as possible, in the time allowed, with all the details of practice. Each class, with the help of the instructors, is expected to make a full set of the patterns needed for the construction of some special piece of working machinery.

In the *Foundry* the student learns to mould in green sand, in dry sand, and in loam, both for brass and for iron castings. Instruction is given in the making of cores for various purposes, and their use in the moulds; and in the art of selecting and mixing metals so as to produce the kind of material desired, careful attention being paid to the making of composition metals for specific purposes. Each student is required to take part in all of the work about the cupola and the brass furnaces, and to assume his share of their management during the periods of melting and casting.

In the *Forge Shop* the student is required to make forgings from a large variety of irons and steels. In this way he becomes familiar with different kinds and qualities of materials suited for forge work; he learns how to heat, forge, anneal, harden, and temper such tools as are used in machine shops; and he also has practice in soldering and brazing. The object of the course is to enable the student to acquire a certain degree of skill in practice, and at the same time impart to him a knowledge of the principles governing such processes of forging as an engineer is likely to be called upon to direct.

In the *Machine Shop* the instruction is conducted on the same plan as in the pattern shop. On the completion of the series of graded exercises, the student begins the construction of parts of machines. Each class undertakes the building of one or more simple machines, or pieces of apparatus; the work being planned in such a way as to give opportunity for learning general shop manipulation. Advanced students are also allowed to elect extra work and to assist the skilled workmen in the construction of larger machines.

Manual Training.—In all the above-described courses advanced work can be taken by students who wish to become specially skilled in certain lines, or who desire to fit themselves for instructors in Manual Training Schools or in shops of that character.

A description of the engineering shops is given on page 24.

Surveying.—(*a*) *For Students in Civil Engineering.*—The course covers a full academic year and includes text-book work, lectures, recitations, and field practice. The methods of surveying and computing used in laying out work are explained in detail; each student is required to make plats, maps, and the necessary calculations from actual surveys; and instruction is given in the proper care, use, and adjustments of instruments. There is an ample and varied supply of instruments for the use of students.

The class room instruction embraces the following topics: instruments and their adjustments; surveys for the enclosure and division of land; some account of the United States Land Survey; city surveys and town plats; surveys of lines of communication, such as roads, railways, and canals; hydrography; special surveys for various purposes of construction, such as laying out buildings, culverts, and abutments, and locating bridge piers; and, in general, the elements of all the ordinary operations to be expected in the professional practice of a civil engineer, but without including Land Surveying in the broad sense of the term. The principal text-books used are Johnson's Surveying, Raymond's Surveying, and Searle's Field Engineering. The more important works of reference are also easily accessible to the student.

The practical work outlined below, and carried on in the fall, early winter, and spring of each year, is intended to cover the elementary operations required in making surveys for engineering works, such as roads, streets, railways, canals, enclosures of land, public improvements, and the laying out of structures on the ground.

The steel-tape practice includes linear measurements, ranging lines, measuring and laying-out angles, laying-out circular curves, and making the records and computations pertaining to such work. With the transit and steel tape the student has practice in reading angles; traverse surveying; laying-out circular curves, simple and compound; and running straight lines. He is also required to keep the records and make the calculations connected with such work, to make plats, and to compute areas. The practical work with the level and rod includes simple levelling, check levels, and profile levelling, together with the necessary field notes and checks. The practice in topography embraces the use of the transit and stadia; plane-table work; and surveying with aid of the camera, including the development of negatives and the printing and mounting of photographs. From the field notes and photographs maps are made by the student. In this connection, also, the student has practice in making blue prints from negatives and from drawings.

During the last month of the academic year the class is in camp as a field party. A survey is made for some line of communication, usually a railroad, including exploration, preliminary and located lines, easements to curves, profile levelling, check levels, profile making, cross-section data, cross-sectioning, transfer of line to plugs near grade points, witnessing, and, in general, the preparation of the line for construction up to the point of beginning excavation. In this connection good field and office records are required; profiles and maps are made; and the necessary computations, including those for earthwork quantities, are worked out.

In addition to the railroad survey some other piece of field work is undertaken, the selection being made according to the fitness of the locality, the number and the previous experience of the members of the class, the time, and the weather, the purpose being to fix, by practical application, the principles learned from text-book, lectures, or previous experience. Within the past few years work of the character indicated below has all been done, though not all in any one year:—small triangulation surveys, in which there is considerable reading of angles; compass surveys; shore-line surveys; surveys for special purposes, like town sites, bridge sites, cemeteries, or particular areas of unusual shape; resurveys of the United States Land Survey, including the finding and restoring of lost corners, and the subdivision of sections; contouring; hydrography; gauging of streams; levelling for special purposes, such as mill powers, lake levels, and the determination of the fall of streams; and, in general, any ordinary piece of field work, for which the locality chosen for the camp may afford favorable conditions.

The work in camp also includes office work along the various lines of field work, such as the computation of triangulations; reductions of careful measurements; calculation of earthwork, azimuth, areas, and elevations; mapping; platting; and profile-making.

(*b*) *For Students in Mechanical Engineering.*—The student in mechanical engineering takes a short course in the use of instruments, which is nearly all practice. He is required to read angles with a transit; to make a traverse; to make steel-tape measurements; to do simple levelling; and to compute and plat an enclosure survey. The aim of the course is to cover the simple manipulations in the ordinary use of surveying instruments, and to qualify the student for such duties in this line as are apt to fall to the mechanical engineer, such as mapping an enclosure, staking out a building and fixing the levels for it, laying out foundations for machines or boilers and establishing the levels for them, lining up shafts, setting water power machinery, and preparing lines for transmission of power by wire-rope, compressed air, or water.

(*c*) *Other Courses.*—Courses in Land Surveying, the United States Land Survey, the Canadian Survey, and in other specialties are provided, if properly qualified persons present themselves in sufficient number to form classes.

Geodesy.—For students prepared to undertake the work a course is offered, comprising lectures, reference reading, and written class reports, on geodetic methods in the field with special reference to successful present day practice. Some consideration is given to notable historical surveys, and constant use is made of the standard works of reference and reports.

Highway Construction.—A short course, comprising lectures, text-book, and examinations, is given to students of civil engineering, on the construction and maintenance of roads, streets, pavements, and walks. References are made to existing examples and present practice. Byrne's Highway Construction is used as a text-book.

Municipal Engineering.—A course of lectures, prescribed reading, and recitations covers the special field of city engineering, points out its connection with, and dependence upon, other branches of engineering work, and shows how to apply the principles of engineering to the modern problems arising in the building and improving of cities. Among the topics treated are streets and their present uses, sewers, waterworks, public franchises, assessments, bridges, building inspection, fires, lighting, street cleaning, and garbage disposal. The instruction is not intended to be of a technical character, but it aims to set forth the principles that should guide the city engineer in his relations to various matters of public concern, and to supplement and apply to this special field the instruction given in other courses. This course should not be taken by undergraduates before their last year of residence.

Strength and Resistance of Materials.—A course of recitations and lectures continuing through the first half-year is devoted to this subject, and is attended by all the engineering students. The action of the different materials under applied forces, the distribution of stress, and the proper proportions to be given to the different parts of structures in order that they may safely fulfil their several functions, are carefully studied. Greene's Structural Mechanics is used as a text-book.

Tests of wood, iron, steel, cement, and other building materials are made in the Engineering Laboratory.

Theory of Structures.—Roof and bridge trusses, in wood and iron; arches, in wood, iron, and stone; trestles; brick and stone masonry; foundations; tunnels; and, in general, the whole theory of structures are discussed. In this course Rankine's Civil Engineering is used as a text-book, supplemented by full explanations, additional notes, lectures, examples, and problems.

A course of instruction extending through a year is also given in the graphical analysis of roof and bridge trusses and arches. The student is made familiar with both the analytical and graphical methods of treatment and thus possesses ready proof of the accuracy of his calculations. Greene's Roof Trusses, Bridge Trusses, and Arches, are used as text-books.

Hydraulics.—The law of the flow of water through orifices and pipes and over weirs; the gauging of streams and rivers; the designing of works for water supply, drainage, and sewerage; the laying out of canals; and the subject of river and harbor improvements are treated in this course. The text-book used is Merriman's Hydraulics.

Machinery, Prime Movers, and Millwork.—A course of instruction is given in mechanism, or the general principles of machinery, involving the study of gearing, screws, cranks, and levers, and the dynamics of machinery. In the study of prime movers, special attention is given to turbine and other water motors, and to steam engines. In the theory of machine construction, problems involving the strength and design of machines, and the materials used in their construction, and also involving the application of the principles of electricity, are studied at length in connection with such examples as illustrate the best practice. The instruction in millwork covers the distribution of power and the arrangement of shafting and machinery in manufacturing establishments. Practical problems involving the strength of shafting, belting, and gearing are fully treated. Tests are made to determine the efficiency of machines, and the value of lubricants.

Design of Shop Machinery.—The student is taught to design one or more of the standard machines used in shops. He is shown how to combine his theoretical and his practical knowledge so as to conform to the best mechanical practice. He designs one or more complete machines and makes a detailed drawing of each part for shop use. The drawings that possess merit and are carefully worked out are subsequently used in the shops. Instruction is also given in blue-print work. The course is conducted in every respect to represent, as far as possible, the operations of actual business.

Designs in Engineering and in Machine Construction.—Contemporaneously with the study of theory students are required to work out problems in design. They are furnished with the usual data for a design, and the kind or type of structure or machine is indicated. They are then expected to make the necessary calculations, paying particular attention to proportioning the different parts so as to secure strength, simplicity, and effect, and to present at a specified date complete working drawings, giving full details, accompanied by bills of materials, estimates, and specifications.

A course in **Thermodynamics** embraces the study of the principles governing the action of heat engines in general, hot-air and gas engines, air compressors, compressed-air engines, and refrigerating apparatus.

Steam Engineering.—The work in this branch covers the practical use of steam. Furnaces and boilers are studied with reference to proper combustion of fuel; to securing maximum evaporative efficiency; and to proportioning the parts for strength, durability, and accessibility for cleaning and repairs. The care and management of engines and boilers, both in use and out of use, are fully considered. A study is made of the principal steam pumps and pumping engines. The practical application of steam to heating and ventilating purposes is treated by lectures, and by inspection of actual plants. Tests are made to determine the value of fuels, quality of steam, and the efficiency of furnaces, boilers, and engines.

Marine Engineering and Naval Architecture.—The instruction in this branch comprises the study of marine steam engines and propelling instruments, the hydraulics of ship building, buoyancy, metacentre, stability and trim, weight and centre of gravity, waves and rolling, structural strength, speed and resistance, propulsion by sails and steam engines, laying-off and taking-on, and other topics.

Metallurgy.—A course of instruction by lectures and recitations is given upon the subjects of fuel, refractory material, iron, and steel. The lectures are illustrated by charts and drawings of furnaces and appliances used, and by samples of furnace products.

Primary and Storage Batteries.—A brief course combining theory and experimental work in measuring electromotive forces, polarization, internal resistance, and efficiency. Several types of storage cells are in constant use.

Electrical Measurements.—This course extends through an entire year and is devoted to practical work in the laboratory with the most modern apparatus. In addition to exact methods of measuring resistances, electromotive forces, and currents, it includes the calibration of the measuring instruments employed, the determination of capacity in absolute measure, the measurement of inductances, and the determination of the hysteresis curves of iron and steel.

Dynamo Electric Machinery.—The time given to this course is about equally divided between the study of the theory of generators and motors, and the determination in the electrical engineering laboratory of characteristic curves, of the series turns required to compound for constant potential, and the efficiency of generators and motors.

Alternating Current Machinery.—To the theoretical study of this subject has recently been added laboratory work with alternators, transformers, and two-phase or three-phase transmission. Highly satisfactory machines have been built by electrical engineering students in the engineering shops.

Design of Electrical Machinery.—The course in electrical design gives the fundamental principles and illustrates them by numerical calculations of electromagnets, of direct current machines, motors, alternators, and transformers. The lecture course is supplemented by exercises in drawing in which each student makes working drawings to accompany his own designs.

Visits of Inspection.—As often as practicable, visits are paid to neighboring manufacturing establishments, and to electric light and electric-power stations, for the purpose of acquiring a knowledge of the methods employed in building, in the construction of bridges, machinery, and ships, and the best practice in electrical manufacturing and engineering on a large scale.

Examinations.

Examinations, usually in writing, are held at the end of each semester, but the classes are liable to be examined at any time, without notice, on any portion of their previous work.

FACILITIES FOR INSTRUCTION.

The collections for illustrating the instruction given comprise models, drawings, photographs, lithographs, and blue prints representing trusses, arches, and details of construction in iron, wood, and stone; also shapes of iron, working models of turbines and engines, and working drawings of a number of bridges. These collections are receiving additions from year to year, by gift and purchase, and are invaluable to the student.

Tests of engines and boilers, and of machinery in general, will be made on request, and the profit of such work devoted to extending the facilities of the engineering laboratory. The data of all experiments and tests made are kept in the laboratory records.

All the laboratory work is on a practical basis, and is done as nearly as possible as it would be done in any well arranged manufacturing establishment. There is a metallurgical laboratory connected with the chemical laboratory, amply supplied with assay furnaces and other appliances. The latest and best books on professional subjects are added yearly to the library, where they are accessible to all; and frequent references are made to them in the class room as the various subjects are brought forward.

Physical Laboratory.

The ground floor of the physical laboratory is devoted to the experimental work in electricity and magnetism. All of this work is open to students in physics.

On the first floor are a commodious lecture room, an apparatus room, a large general laboratory for the elementary practical courses, a balance room, one room for advanced work in sound and light, and two private rooms.

In addition to the large collection of apparatus for electrical measurements, the laboratory is supplied with the best from the most celebrated makers. In sound it includes tuning forks, resonators and special apparatus from Koenig, of Paris; in light, an ophthalmo-spectroscope from the Geneva Society, an optical bench with numerous accessories from Duboscq, a Zeiss focometer, spectrometer, and interferometer, a polarimeter from Schmidt & Haensch, besides many telescopes and valuable accessories for investigation in light.

The work in the physical laboratory is entirely quantitative in character. The apparatus includes, however, ample provision for illustrating the general principles and laws of physics in the lecture courses.

Chemical Laboratories.

The chemical laboratories provide for classes in general, analytical, organic, and physical chemistry, in pharmacy, in chemical technology, and in metallurgical assaying. They also provide for original research in the several branches of chemical science and for independent investigations. In the course of the year, classes are formed in forty-six distinct courses of study. In the greater number of these courses the method of work combines training in laboratory operations with instruction by lectures and conference, these methods being united in one course.

The chemical building contains in all about 37,000 square feet of floor space. Besides the rooms for recitations, storage, administration, etc., the laboratories for students have an area of about 25,000 square feet.

The laboratory of general chemistry is separately organized. Courses in elementary inorganic chemistry, as well as in physical chemistry and the advanced branches of the science are offered; research work both in inorganic and in organic general chemistry is also arranged for a limited number of students, and is carried on in a separate room. Modern apparatus is on hand for all the varieties of work that are liable to be undertaken, and a well equipped balance room is provided.

The laboratories of analytical chemistry, organic chemistry, pharmacy, and chemical technology, are carried on together. There are separate work rooms for qualitative analysis, quantitative analysis, iron and steel analysis, electrolytic work, pharmaceutical preparations, organic preparations, organic analysis, physiological chemistry, and assaying of ores,—as well as rooms for the weighing balances and instruments of precision, for gas analysis, and for optical work. There are eleven separate rooms for original research. The building contains two lecture rooms, two recitation rooms, and a museum with collections for instruction in chemistry, pharmacy, pharmacognosy, and chemical technology. In the ventilation of the work rooms the supply of fresh air is enforced by driving fans, and the removal of foul air is effected by strong draught flues, with which, also, work-hoods are connected.

The chemical laboratories are open throughout the college year to all students of the University, and are regularly used by the several departments. They are also open to any person who wishes to pursue special studies therein, provided he complies with the conditions for admission to that department of the University to which the desired special studies properly belong.

Over three hundred students are engaged in these laboratories at the same time, each at a table provided for one worker. During the year, from 600 to 700 students complete from one to five courses of study each in the various branches of chemistry.

ENGINEERING SHOPS.

The engineering shops are in a group of connected buildings, containing about 17,000 square feet of floor space devoted to shop work.

The *Wood and Pattern Shop*, 40 by 80 feet, is equipped with the tools and machinery usually found in a first-class establishment. One end of the shop contains the work-benches and the tools needed for hand work; the other contains a good variety of wood-working machinery, much of which was built in the shops. Above the wood-room a pattern-loft, 40 by 80 feet, contains a large collection of patterns made by students during the past few years.

The *Foundry*, 30 by 40 feet, is equipped with two iron cupola furnaces, one capable of melting six hundred pounds, and the other two tons, of iron an hour; two brass furnaces of a capacity of 150 pounds each; a modern core-oven; elevators; crane; blowers; and a supply of flasks and small tools adapted to the work to be done. A large part of this equipment was made in the shops.

The *Forge Shop*, 30 by 40 feet, contains twelve forges and anvils, a drill press, an emery wheel, pressure and exhaust blowers, and many small tools. During the current year a punch and shear will be added.

The *Machine Shop*, 40 by 80 feet, contains lathes, planing machines, drill presses, a milling machine, a shaper, and other tools for working in iron. Much of this machinery was made in the shop. The tool room is well supplied with small tools.

The *Drawing Room*, 32 by 54 feet, is supplied with blue-print apparatus, drawing desks, and other furniture needed for the use to which the room is put.

The central portion of the building, 32 by 54 feet, contains on the first floor a well-ventilated wash-room, an engine room with a 10 by 30 Reynolds-Corliss engine, and an office for the superintendent. The basement and the attic are used for storage.

New machinery is added to each shop from time to time for the accommodation of engineering students and others desiring instruction and practice in the use of tools for working in wood and metal. At the same time opportunity is afforded them to become familiar with the more common materials and forms of construction used in engineering structures, buildings and machinery. In all work an effort is made to follow the practice of the best shops.

ENGINEERING LABORATORY.

The *Engineering Laboratory*, 40 by 80 feet, is devoted to experimental work in connection with the testing of engines, boilers, pumps, indicators, belting, gearing, lubricants, and strength of materials, and to such original work as can be undertaken with advantage. The work also extends to the testing of engines, boilers, and water-wheels of neighboring mills and electric plants. The Knowles and the Gordon pumping engines at the City Water Works have been fitted up by the company with especial reference to the convenience of engineering students in making tests. The equipment contains, among other things, a 100,000-pound Olsen testing machine; a 2,000-pound cement testing machine; Thurston and Ashcroft oil testing machines; a Stirling boiler for high pressure; a high speed automatic engine; a Corliss engine; a Rider hot-air engine; Wheeler and Wainright surface condensers; an Alden absorption dynamometer; a Giddings traction recording dynamometer; an Emerson power-scale; several other forms of dynamometers; a large, electrically driven chronograph, built in the laboratory; a 36-foot open mercury column; special apparatus for testing pressure and vacuum-guages, and indicator springs; guages; indicators; thermometers; pyrometers, tachometers; standard weights; steam pumps and injectors; rotary and centrifugal pumps; water meters; water motors, including a special universal water motor, built in the laboratory, together with pressure tanks and pumps for testing motors; hydraulic rams; water-wheels; air-pumps; blowers; apparatus for making tests on radiators and pipe coverings; apparatus for furnace gas analysis; a street railway motor; and other apparatus having special reference to work of investigation.

THE ELECTRICAL LABORATORY.

The entire ground floor of the physical laboratory is devoted to experimental work in electricity. The rooms for electrical measurements contain solid stone-capped piers, and currents under a pressure ranging from 2 to 220 volts are available.

The laboratory is supplied with apparatus from the best American and European makers. It contains galvanometers and resistance boxes from Hartmann & Braun, Elliott Brothers, Nalder Brothers & Co., Queen & Co., and Willyoung & Co.; a series of ammeters and voltmeters from the Weston Co., for both direct and alternating currents; also condensers, electrodynamometers, electrostatic voltmeters, three Kelvin balances, standard cells, standard resistance coils, standard condensers and an Ayrton & Perry standard of self-inductance.

In the dynamo room are two 10-light arc machines, two constant potential machines, and a 33 K. W. composite wound alternator made for the University by the Fort Wayne Electrical Corporation. These are all run from a counter shaft which is driven by a 50 H. P. 220-volt motor made by the Excelsior Electric Co. In addition, a small alternator for single phase, two-phase, or three-phase experimental work is run by a separate motor. Arc lamps, banks of incandescent lamps, resistances, rheostats, transformers and storage batteries complete the equipment. The transformers include a set for conversion from two phase to three phase transmission and the reverse. A well equipped photometric room adjoins the dynamo room.

The new University lighting plant, consisting of two 75 K. W. Thompson-Ryan generators and one 25 K. W. Westinghouse generator, is available for instruction in the department. The two large machines are connected by the Arnold system to two 15x14 engines and run at a speed of 250 revolutions per minute. The Westinghouse machine is direct connected to a Russell 9x12 automatic engine running at 300 revolutions per minute. The latter is located at the hospitals which may be lighted independently, or may be supplied with current from the central plant on the campus by means of heavy mains and a "booster." The system is a 220 volt one throughout, with both incandescent and arc lamps (two in series) on the same circuits. All the feeders and mains are underground, except those running from the central plant to the hospitals and to the observatory.

The Arnold system permits of connecting either dynamo to either engine, or of disconnecting either so that it may be tested for efficiency by purely electrical methods. A large number of motors, varying in capacity from 1 to 50 H. P., are in service, and are available for testing purposes.

The Astronomical Observatory.

The Observatory is known as the Detroit Observatory, having been founded through the liberality of citizens of Detroit. Valuable additions and improvements have been made by contributions from several sources. The building consists of a main part, with a movable dome, and two wings. The meridian circle in the east wing was presented by Mr. Henry N. Walker, of Detroit. It was constructed by Pistor & Martins, of Berlin. In the main part are mounted clocks by Tiede and Howard. The west wing contains the observatory library, which connects with the residence of the Director. The refracting telescope, mounted in the dome, has an object glass thirteen inches in diameter. It was constructed by the late Henry Fitz, of New York.

A small observatory near the main building is used in the work of instruction. It contains an equatorial telescope of six inches aperture, and a transit instrument of three inches aperture, with zenith telescope attachment. A certain amount of practice in determination of time, latitude and longitude is required of all civil engineering students.

Geological Laboratory.

Opportunity for practical work in geology is provided in rooms set apart for this use in the Museum building, The rooms are furnished with microscopes, photographic instruments, cutting and polishing lathes, and other apparatus for the preparation of specimens. Special encouragement and assistance are given to students wishing to carry on original investigations.

The Libraries.

The various libraries of the University contain about 114,000 volumes, and include a number of important special collections. The portion devoted to engineering contains the standard works in this department of science, and the files of important society proceedings and professional periodicals. Six hundred and twenty-five periodicals are received.

The catalogue of the library is the usual card catalogue of authors and subjects.

Members of the faculties and other officers of the University may draw books from the library, subject to certain restrictions. To all other persons it is a reference library. The reading room for general use will seat 210 readers. Separate rooms are provided for advanced students where work is pursued with the necessary books at hand.

The library is open for consultation fourteen hours daily during the academic year, nine hours daily during the six weeks of the Summer School, and six hours daily from the close of the Summer School until the end of the summer vacation. The only exceptions to the above are Sundays and legal holidays.

The Engineering Society.

Several organizations of students are maintained, aside from the usual literary societies, for the reading of papers and holding discussions in various scientific lines. The Engineering Society, composed of and officered by students of this department, holds weekly meetings, at which papers of technical interest are read, and reports made upon observation and experiments. A reading room is maintained by the Society, accessible to all students of the department. Seneral engineers of prominence have spoken before the Society the past year. An annual, called the Technic, containing papers read before the Society, abstracts of theses, contributed articles from alumni, and other matters of professional interest, is published by the students.

THE SUMMER SCHOOL.

The Summer School, in session from July 6 to August 18, 1898, affords opportunity for study in languages, history, mathematics, natural, physical and applied science, and for work in the drawing rooms and laboratories. A special Announcement can be had by addressing Mr. James H. Wade, Steward of the University.

FACILITIES FOR PHYSICAL CULTURE.

Waterman Gymnasium.—The University is provided with an excellent gymnasium which has cost about $65,000. The main floor, which is a rectangle with truncated corners and dimensions of 150 by 90 feet, is well equipped with the various kinds of apparatus usually found in the best modern gymnasiums. A number of the smaller rooms are devoted administration, fencing, boxing, and other special purposes, while the basement is given up to baths and lockers. The main hall is lighted in the day time by means of a large skylight 60 feet above the floor, and in the evening by electricity, A gallery makes room for an elliptical running-track 375 feet in length.

In the conduct of the gymnasium the aim is not so much the development of a few gymnastic experts as the provision of wholesome physical exercise for the many. Thus far the work has been voluntary. The facilities of the building, including physical examinations and instruction, are free to all students, the only charge being a rental of $2 a year for a locker.

An athletic field of ten acres has been set apart and equipped for open air sports. Room is also provided for tennis courts. Foot-ball and base-ball are practiced by class and University teams.

THE LABORATORIES.

For a full account of all the laboratories and their various resources, as also of the University collections for the study of art, archeology, ethnology, mineralogy, paleontology, systematic zoology, etc., consult the annual Calendar, which may be had gratis on application to Mr. James H. Wade, Steward of the University. Those laboratories closely connected with the Department of Engineering are described in the preceding pages.

UNIVERSITY ORGANIZATIONS.

An attractive series of lectures and musical entertainments is provided each year at a low price by the Students' Lecture Association. The Choral Union is an organization of students and others for the study and practice of choral music. A course of concerts and a festival of three days in May are announced under its auspices each year.

The Oratorical Association fosters an interest in oratory, and its members have been remarkably successful in recent contests.

COURSES OF INSTRUCTION.

The Courses of Instruction are subject to change from time to time; those announced for the year 1897–98 and required for graduation, as stated on pages 42 to 44, are described below, together with some technical elective courses which are designated accordingly. The amount of credit towards graduation assigned to each course is indicated by the expressions *one hour*, *two hours*, etc., an *hour of credit* being given for the satisfactory completion of work equivalent to one exercise a week during one semester. Lectures and recitations are usually one hour in length, but in laboratory work, drawing, and other practical exercises, a longer attendance is required in order to secure an hour of credit.

The courses given in the Department of Literature, Science, and the Arts, are (with the exception of the courses in French and in German, for which special permission is required) all open as electives to engineering students who are qualified to pursue them with advantage.

FRENCH.

FIRST SEMESTER.

A. Beginners' Course. *Three hours.* Mr. BRANDON.
C. Descriptive prose. *Three hours.* Mr. BRANDON.
D. Advanced Scientific Reading. *Three hours.* Mr. BRANDON.

SECOND SEMESTER.

B. Narative Prose. *Three hours.* Mr. BRANDON.
E. Current Scientific Literature. *Three hours.* Mr. BRANDON.

German.

FIRST SEMESTER.

A. Elementary Course. Thomas's German Grammar, and a German Reader. *Three hours.* Mr. LAUTNER.

C. Descriptive Prose. *Three hours.* Mr. LAUTNER.

D. Scientific Prose. *Three hours.* Mr. LAUTNER.

SECOND SEMESTER.

B. Elementary Course, continued. *Three hours.* Mr. LAUTNER.

E. Scientific Prose. *Three hours.* Mr. LAUTNER.

English.

FIRST SEMESTER.

1. Paragraph Writing. Three sections. *Two hours.* Mr. STRAUSS.

SECOND SEMESTER.

1*a*. Theme Writing. *Two hours.* Mr. STRAUSS.

Mathematics.

Students of engineering are required to take in order Courses 1, 2, 3, 4 and 6. They are also required to take Course 1*b*, unless they have passed a satisfactory examination for admission in plane trigonometry, but no credit toward graduation is given to engineering students for Course 1*b*.

FIRST SEMESTER.

1. Algebra and Analytic Geometry (I). Four sections. *Four hours.* Mr. LYMAN, Mr. HALL, Dr. GLOVER, and Mr. GODDARD.

1*b*. Plane Trigonometry. Two sections. *Two hours.* Mr. GODDARD.

3. Calculus. Four Sections. *Five hours.* Professor ZIWET, Assistant Professor MARKLEY, and Mr. LYMAN.

6. Calculus and Mechanics (II). Three sections. *Four hours.* Professor ZIWET and Mr. LYMAN.

SECOND SEMESTER.

2. Analytic Geometry (II). Five sections. *Four hours.* Mr. LYMAN, Mr. HALL, Dr. GLOVER and Mr. GODDARD.

4. Calculus and Mechanics (I). Four sections. *Five hours.* Professor ZIWET, Assistant Professor MARKLEY, and Mr. LYMAN.

Physics.

FIRST SEMESTER.

2. Heat, Electricity, and Magnetism. Lectures and recitations. *Five hours.* Professor CARHART and Assistant Professor REED.

Course 2 must be preceded by Course 1 and a course in general or in analytical chemistry.

3. Physical Laboratory Work for Beginners. This course may be elected as 3*a*, *three hours;* or 3*b*, *two hours.* Professor PATTERSON and Assistant Professor REED.

Course 3 is also given in the second semester. It must be preceded or accompanied by Course 1. Students presenting notebooks from High School physical laboratories approved by this department, by electing Course 3*a*, may be allowed *three hours* of credit for *two hours* of work. Fee: for Course 3*a*, $3; for 3*b*, $2.

7. Electricity and Magnetism. *Three hours.* Professor PATTERSON. (Elective.)

Course 7 must be preceded by Course 2. A knowledge of calculus is required.

8. Heat. Laboratory work. *Two hours.* Dr. GUTHE. (Elective.)

Course 8 must be preceded by Course 2. Fee, $2.

9. Theory of Heat: Preston. *Two hours.* Professor CARHART. (Elective.)

SECOND SEMESTER.

1. Mechanics, Sound and Light. Lectures and recitations. *Five hours.* Assistant Professor REED.

For Course 1 a knowledge of plane trigonometry is indispensable.

3. Physical Laboratory Work for Beginners. This course may be elected as 3*a*, *three hours;* 3*b*, *two hours;* or 3*c*, *three hours.* Professor PATTERSON, Dr. GUTHE, and Mr. JONES.

See note to Course 3 in first semester. Course 3*c* treats of mechanical and electrical measurements; it is designed for engineering students who wish to elect Course 4*a* in electrical engineering. Fee for Course 3*a*, $3; for 3*b*, $3; for 3*c*, $3.

10. Electricity and Magnetism. *Two hours.* Professor PATTERSON. (Elective.)

Course 10 must be preceded by Course 7.

16. Theories of Solutions, Electrolytes, and the Voltaic Cell. Lectures and laboratory work. *Three hours.* Dr. GUTHE. (Elective.)

Course 16 must be preceded by Course 2 in electrical engineering and by Course 1 in chemistry. It is also desirable that the student have had laboratory work in chemistry. Fee, $1.

Chemistry.

1. Elementary Inorganic Chemistry. Experimental lectures and recitations. *Three hours.* Mr. HIGLEY.

EITHER FIRST OR SECOND SEMESTER.

2. Laboratory Work in General Inorganic Chemistry. *Three or more hours.* Mr. HIGLEY, Mr. LICHTY, and Dr. SHERMAN.

Course 2 must be preceded or accompanied by Course 1 or an equivalent. It is supplementary to Course 1 and covers in the laboratory the ground covered by lectures in Course 1.

3. Qualitative Analysis. Recitations and laboratory work. *Five hours.* Professor O. C. JOHNSON. (Elective.)

METALLURGY.

FIRST SEMESTER.

1. Fuel and Refractory Material, Iron and Steel. *Three hours.* Professor CAMPBELL.

Course 1 must be preceded by Course 1 or Course 3 in chemistry.

EITHER FIRST OR SECOND SEMESTER.

2. Micro-Metallography. The study of the microscopic structure of metals as related to their physical and chemical properties. Laboratory work with reading. *One hour.* Professor CAMPBELL. (Elective.)

Course 2 can be taken only by those who have taken Course 1 and who receive special permission.

ASTRONOMY.

FIRST SEMESTER.

3. Spherical Astronomy, elementary course, with exercises in computing. *Two hours.* Professor HALL. (Elective.)

EITHER FIRST OR SECOND SEMESTER.

4. Practical Astronomy. Use of sextant and transit. *Three hours.* Mr. TOWNLEY.

Course 4 requires a knowledge of spherical trigonometry and of differential and integral calculus.

MINERALOGY.

EITHER FIRST OR SECOND SEMESTER.

1. Lectures and practice. *Two hours.* Professor PETTEE.

For Course 1 an elementary knowledge of chemistry is desirable.

GEOLOGY.

FIRST SEMESTER.

1. Elements of Geology—lithological, structural, and dynamical. Lectures and recitations. *Three hours.* Professor RUSSELL.

DRAWING.

FIRST SEMESTER.

1. Geometrical Drawing. Practice. Four sections. *Two hours.* Mr. GOULDING.

4. Free-Hand Drawing; Pencil Drawing; Pen and Ink Drawing; Sketching. Four sections. *Three hours.* Professor DENISON, Mr. WRENTMORE, and Miss HUNT.

10. Continuation of Course 8. *Two hours.* Professor DENISON and Miss HUNT. (Elective.)

Course 10 must be preceded by Courses 4, 7 and 8.

13. Water-Color Drawing. *Three hours.* Professor DENISON and Miss HUNT. (Elective.)

Course 13 must be preceded by Course 8. It can be taken only by special permission.

SECOND SEMESTER.

5. Descriptive Geometry. Recitations and drawing. Five sections. *Four hours.* Professor DENISON, Mr. WRENTMORE, and Mr. GOULDING.

Course 5 must be preceded by Course 1.

6. Shades, Shadows, and Perspective. *Three hours.* Professor DENISON. (Elective.)

Course 6 must be preceded by Course 5.

7. Free-Hand Drawing (advanced). *Three hours.* Professor DENISON and Miss HUNT. (Elective.)

8. Architectural and Water-Color Drawings. *Two hours.* Professor DENISON and Miss HUNT. (Elective.)

Course 8 must be preceded by Course 1 or 4.

14. Stereotomy. *Two hours.* Professor DENISON.

Course 14 must be preceded by Course 5.

16. Free-Hand Lettering. *Two hours.* Mr. WRENTMORE. (Elective.)

Course 16 must be preceded by Course 1.

17. Spherical Projections. *One hour.* Professor DENISON. (Elective.)

Course 17 must be preceded by Course 5.

Shop Practice.

All courses in shop practice are under the supervision of Professor C. G. TAYLOR, to whom application must be made for assignment to sections. Professor TAYLOR also gives a few lectures on appliances and materials in each of the Courses 1*a*, 2*a*, 3*a*, and 4*a*. These courses may also be continued by advanced students as Courses 1*b*, 2*b*, 3*b*, and 4*b*, the credit in each case being arranged with instructor.

Special arrangements will be made for students who desire to take more advanced work in the shop courses with a view to preparing themselves for teaching these subjects.

EITHER FIRST OR SECOND SEMESTER.

1*a*. Wood Work and Pattern Work. Three sections. *Two hours.* Mr. PURFIELD. Fee, $5.

1*b*. Pattern Work, advanced. *Two hours.* Mr. PURFIELD. Fee $5.

2*a*. Forging. Five sections. *Two hours.* Mr. McDONALD. Fee, $5.

3*a*. Foundry Work. Three sections. *Two hours.* Mr. WINSLOW. Fee, $5.

4*a*. Iron Work. Three sections. *Three hours.* Mr. SMOOTS. Fee, $5.

4*b*. Iron Work, advanced. *Two hours.* Mr. SMOOTS. Fee $5.

Surveying.

FIRST SEMESTER.

1. Lectures and Field Practice with Instruments. *Four hours.* Professor J. B. DAVIS.

The field practice in Course 1 continues during favorable weather until Christmas.

4. Use of Instruments. *One hour.* Professor J. B. DAVIS.

6. Continuation of Course 5. Phototopography. Field work and drawing. *One hour.* Professor J. B. DAVIS.

The ability to make photographic negatives will be of service.

SECOND SEMESTER.

2. Continuation of Course 1. Lectures and text-book. *Five hours.* Professor J. B. DAVIS.

Course 2 must be preceded by Course 1.

3. Field Work in Camp for Four Weeks. Professor J. B. DAVIS.

Course 3 must be preceded by Courses 1 and 2. Except by special permission it is open only to students who are working for a degree in civil engineering.

5. Topography. Transit and Stadia. Plane Table. Field work and drawing. *Three hours.* Professor J. B. DAVIS.

Course 5 is given four times a week for thirteen weeks.

7. Geodesy. Geodetic Methods. Lectures and text-book. *Three hours.* Professor J. B. DAVIS. (Elective.)

Course 7 must be preceded by Courses 1 and 2. It is given five times a week for twelve weeks.

Civil Engineering.

FIRST SEMESTER.

1. Municipal Engineering. Lectures and text-book. *Five hours.* Professor J. B. DAVIS. (Elective.)

4. Graphical Analysis of Structures. *Two hours.* Professor GREENE.

Course 4 must be preceded by Course 3.

6. Engineering. Theory of Construction. *Two hours.* Professor GREENE.

Course 6 must be preceded by Course 4 in mathematics.

7. Engineering Design. *Five hours.* Professor GREENE.
Course 7 accompanies Course 6.

9. Hydraulics. *One hour.* Professor GREENE.

SECOND SEMESTER.

2. Tests of Materials. *One hour.* Professor GREENE. (Elective.)

3. Graphical Analysis of Structures. Two sections. *Two hours.* Professor GREENE.
Course 3 requires at least a limited knowledge of statics.

5. Strength and Resistance of Materials. Two sections. *Two hours.* Professor GREENE.
Course 5 must be preceded by Course 4 in mathematics.

8. Engineering. Theory of Construction. *Three hours.* Professor GREENE.

10. Water Supply and Sewerage. *One hour.* Professor GREENE. (Elective.)

Mechanical Engineering.

FIRST SEMESTER.

2. Elements of Mechanism. *Two hours.* Professor DENISON.
Course 2 must be preceded by Course 1 in mathematics, and by Courses 1 and 5 in drawing.

3. Dynamics of Machinery. *One hour.* Mr. FAIG.
Course 3 must be preceded by Course 6 in mathematics and by Course 1 in physics.

4. Boilers. Steam Engines. *Two hours.* Mr. ALLEN.
Course 4 must be preceded or accompanied by Course 3.

5. Mechanism. Valve Gears. *Three hours.* Professor DENISON.

7. Hydraulic Machinery. *One hour.* Professor COOLEY.
Course 7 is intended for those who have taken Course 4. It must be preceded by Course 3.

8. Theory of Machine Design. *Three hours.* Professor COOLEY.
Course 8 must be preceded or accompanied by Course 5 in civil engineering.

EITHER FIRST OR SECOND SEMESTER.

6. Machine Design. Machine Tools. *Two hours.* Professor C. G. TAYLOR.
Course 6 must be preceded or accompanied by Course 2, and be preceded by Courses 1, 4, and 5 in drawing.

9. Laboratory work. Power Measurements. Machine Testing. *Two hours.* Professor COOLEY and Mr. ALLEN. Fee $5.
Course 9 must be preceded by Course 3.

10. Machine Design. Hoisting Machinery. *Three hours.* Professor COOLEY and Mr. FAIG.

Course 10 should be preceded or accompanied by Course 8.

11. Laboratory Work. Steam Engineering. *Three hours.* Professor COOLEY, Mr. ALLEN, and Mr. JONES. Fee, $5.

Course 11 must be preceded or accompanied by Course 4, 7, or 15.

12. Machine Design. Engines and Boilers. *Two hours.* Professor COOLEY and Mr. FAIG.

Course 12 must be preceded or accompanied by Course 8.

SECOND SEMESTER.

1. Elements of Machines. Nomenclature. *Two hours.* Mr. FAIG.

13. Steam Engines and other Heat Engines. *Three hours.* Professor COOLEY.

Course 13 must be preceded by Course 4.

14. Power Plants. Power Transmission. *Two hours.* Professor COOLEY.

Course 14 must be preceded by Course 7 or 15.

15. Prime Movers. Water wheels and steam engines. *Two hours.* Professor COOLEY and Mr. ALLEN.

Course 15 must be preceded by Course 3.

Electrical Engineering.

FIRST SEMESTER.

2. Electrical Measurements: Carhart and Patterson's Electrical Measurements. Recitations and laboratory work. *Four hours.* Professor PATTERSON, Dr. GUTHE, and Mr. JONES.

Course 2 must be preceded by Courses 1, 2, and 3 in physics; a knowledge of calculus is also required. Fee, $3.

5. Alternate Current Apparatus. Recitations and laboratory work. *Three hours.* Professor CARHART and Mr. JONES.

Course 5 must be preceded by Course 4. Fee, $1.

7. Design of Electrical Machinery and Appliances. *Four hours.* Professor CARHART and Mr. JONES.

Course 7 must be preceded by Course 4*a* or 4*b*.

SECOND SEMESTER.

1. Primary and Secondary Batteries: Carhart's Primary Batteries. Recitations and laboratory work. *Two hours.* Dr. GUTHE.

Course 1 must be preceded by Courses 1, 2, and 3 in physics, and by a course in general or in analytical chemistry. Fee, $1.

3. Electrical Measurements. Continuation of Course 2. Lectures and laboratory work. *Three hours.* Dr. GUTHE and Mr. JONES. Fee, $2.

4*a*. Dynamo-Electric Machinery: Thompson's Dynamo-Electric Machinery. Lectures, recitations, and laboratory work. *Four hours.* Professor CARHART and Mr. JONES. Fee, $2.

Course 4*a* must be preceded by Course 2.

4*b*. Dynamo-Electric Machinery, as in Course 4*a*. *Three hours.* Professor CARHART and Mr. JONES. Fee, $1.

Course 4*b* must be preceded by Course 3*c* in physics.

6. Photometry of Electric Lamps: Palaz's Photometry. Recitations and laboratory work. *One hour.* Professor PATTERSON. Fee, $1.

8. Distribution of Electricity. Lectures and recitations. *Two hours.* Professor PATTERSON and Mr. JONES. (Elective.)

Course 8 must be preceded by Course 4*a*.

9. Alternating Current Phenomena: Steinmetz. *Two hours.* Professor CARHART.

Course 9 must be preceded by Course 5.

Marine Engineering.

FIRST SEMESTER.

1. Naval Architecture. Professor COOLEY.

SECOND SEMESTER.

2. Marine Engines. *Three hours.* Professor COOLEY. (Elective.)
3. Ship-Building. Professor COOLEY.

Courses 1 and 3 are for graduates; Course 2 is designed for graduates and for undergraduates who have had the necessary training. It is proposed to extend these courses much more in the near future.

Mining Engineering.

SECOND SEMESTER.

1. Exploitation of Mines. Methods of opening, laying-out, and working mines. *Five hours.* Professor PETTEE. (Elective.)

Course 1 requires a knowledge of mineralogy and general geology.

SEQUENCE OF STUDIES.

The studies of the first and second years are *prescribed,* except so far as credit obtained in advance may leave a place for substitutions, or the presentation of Latin as one of the requirements for admission may make some change necessary. The work for the first year is the same for all students. At the end of the first year, the student makes his choice to continue in the civil engineering, the mechanical engineering, or the electrical engineering course. In the third and fourth years some opportunity for elective studies is open. [For chemical engineering, see p. 44.]

Program of Work.

The order of studies is as follows:

FIRST YEAR.

The same for all regular students.

FIRST SEMESTER.

	EXERCISES PER WEEK.
French or German D.*	3
English 1, Paragraph writing.	2
Mathematics 1, Algebra and Analytic Geometry, I.	4
Drawing 1, Elementary Drawing.	2
Drawing 4, Freehand Drawing.	3
Shop Practice 2*a*, Forging, or 1*a*, Woodwork.	2
(One-half of class.) (One-half of class.)	—
	16

SECOND SEMESTER.

French or German E.	3
Physics 1, Mechanics, Sound and Light.	5
Mathematics 2, Analytic Geometry, II.	4
Drawing 5, Descriptive Geometry.	4
Shop Practice 1*a*, Woodwork or 2*a*, Forging.	2
	—
	18

SECOND YEAR.

The student will now select his course and report it to the Dean. Studies marked C, M, and E are to be taken by civil, mechanical, and electrical engineering students respectively.

FIRST SEMESTER.

German or French A, Beginners' Course.	3
Mathematics 3, Calculus.	5
Physics 2, Heat, Electricity and Magnetism.	5

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*The student who enters with German will continue that language through the first year and begin French in the second year. The student who enters with French will continue French a year and then begin German. The student who enters with Latin will take French or German A.

Physics 3*b*, Laboratory Work.	E	2
Chemistry 2, Laboratory Work.*	C	3
Mineralogy 1.	C	2
Shop Practice 1*b*, Woodwork, advanced.	M	2
Shop Practice 3*a*, Foundry, or 4*a*, Ironwork. (One-half of class.) (One-half of class.)	M, E	2 or 3

C 18; M, E 17 or 18.

SECOND SEMESTER.

German or French B.		3
Mathematics 4, Calculus and Mechanics, I.		5
English 1*a*, Theme Writing.		2
Physics 3*c*, Mechanical and Electrical Measurements.	C, M	3
Geology 1, Elements.	C	3
Drawing 14, Stereotomy.	C	2
Shop Practice 1*b*, Woodwork, advanced.	E	2
Shopwork Practice 4*a*, Ironwork, or 3*a*, Foundry.	M, E	3 or 2
Mechanical Engineering 1, Elements of Machines.	M	2
Electrical Engineering 1, Primary and Secondary Batteries.	E	2

C 18; M 18 or 17; E 17 or 16

THIRD YEAR.

FIRST SEMESTER.

French or German C.		3
Mathematics 6, Calculus and Mechanics II.		5
Mechanical Engineering 2, Mechanism, Elements.		2
Mechanical Engineering 3, Dynamics of Machinery.		1
Shop Practice 4*b*, Ironwork, advanced.	M	2
Surveying 1, Instruction and Practice.	C	4
Surveying 6, Photo-topography.	C	1
Mechanical Engineering 4, Boilers, Steam Engines.	M	2
Mechanical Engineering 5, Mechanism, Valve Gears.	M, E	3
Electrical Engineering 2, Electrical Measurements.	E	4

C 16, M, E 18

SECOND SEMESTER.

Civil Engineering 3, Graphics.		2
Civil Engineering 5, Resistance of Materials.		2
Shop Practice 4*b*, Ironwork, advanced.	E	2

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*Chemistry 3, Qualitative Analysis, *five hours*, may be substituted for Chemistry 2, if the student has advanced credit.

Surveying 2, Advanced Surveying.	C	5
Surveying 3, Field Work in Camp.	C	
Surveying 5, Topography.	C	3
Chemistry 2, Laboratory Work.	M, E	3
Mechanical Engineering 6, Design of Machine Tools.	M	2
Mechanical Engineering 7, Hydraulic Machinery.	M, E	1
Mechanical Engineering 13, Steam Engines.	M	3
Electrical Engineering 3, Electrical Measurements, advanced.	E	3
Electrical Engineering 4*a*, Dynamo-Electric Machinery.	E	4
Electrical Engineering 4*b*, Dynamo-Electric Machinery.	C, M	3

C 15; M 16; E 17

FOURTH YEAR.

FIRST SEMESTER.

Astronomy 4*, Time, Latitude and Longitude.	C	3
Metallurgy 1, Fuel, Iron and Steel.	M	3
Surveying 4, Use of Instruments.	M	1
Civil Engineering 4, Graphics, advanced.	C	2
Civil Engineering 6, Trusses and Structures.	C	2
Civil Engineering 7, Design of Structures.	C	5
Civil Engineering 9, Hydraulics.	C, M	1
Mechanical Engineering 6, Design of Machine Tools.	E	2
Mechanical Engineering 4, Boilers, Steam Engines.	E	2
Mechanical Engineering 8, Theory of Machine Design,	M	3
Mechanical Engineering 10†, Design of Hoisting Machinery. Mechanical Engineering 11, Steam Engineering, Laboratory.	M	3
Mechanical Engineering 9, Power Measurements, Laboratory. Mechanical Engineering 12†, Design of Boilers and Engines.	M	2
Electrical Engineering 5, Alternate Current Apparatus.	E	3
Electrical Engineering 7, Design of Electrical Machinery and Appliances.	E	4

C 10 or 13; M 13; E 11

SECOND SEMESTER.

Astronomy 4*, Time, Latitude and Longitude.	C	3
Civil engineering 8, Theory of Construction.	C	3
Mechanical Engineering 10 or 11. (See 1st Semester.)	M	3

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*One-half of the class will be given instruction in the first semester, the other half in the second semester.

†One-half of the class will take 9 and 10, the other half 11 and 12.

Mechanical Engineering 9 or 12. (See 1st Semester.)	M	2
Mechanical Engineering 14, Power Plants; Transmission.	M	2
Mechanical Engineering 15, Prime Movers,	C	2
Electrical Engineering 6, Photometry; Distribution of Electricity.	E	3
Thesis.		
	C 5 or 8; M 7; E 3	

Total exercises prescribed, C 119; M 123; E 117.

Required for graduation, 130 exercises.

The work of students must be arranged in conformity with the following regulations:

a. Before entering on any study the student must give the instructor satisfactory evidence that he is prepared to pursue it with advantage.

b. No student will be allowed to elect merely a part of a course, without special permission of the Faculty.

c. No credit will be allowed to a student for work in any course, unless the election of the work is formally made and reported to the Registrar before the work is begun.

d. After the second Monday of each semester no study shall be taken up or dropped without special permission of the Engineering Faculty. All requests for permission to take up or drop studies must be made in writing on specially provided blank forms and in accordance with the rules printed thereon.

e. The Faculty will require a student to drop a part of his work at any time, if in its opinion he is undertaking too much; or to take additional work, if it thinks he is not sufficiently employed.

f. The faculty reserves the right to withdraw the offer of any study not chosen by at least six persons.

In cases of exceptional proficiency permission to take hours in addition to those named in the published schedule may be granted by the Faculty on special request; but in all cases requests for permission to take an additional number of hours must be made in writing on a blank form provided by the Dean, and must be deposited in the Dean's box on or before the *first Monday* of the semester during which the additional work is desired. No permission to take extra hours will be granted to students in their first semester of residence.

After matriculation, a student shall not, without special permission of the Faculty, be admitted to examination in any one of the courses given, until he has received in the University the regular instruction in such course.

REQUIREMENTS FOR GRADUATION.*

The Degree of Bachelor of Science.

To earn the degree of Bachelor of Science in civil, mechanical, or electrical engineering, the student must secure ***one hundred and thirty Hours of Credit***† in a prescribed course of study, as given below, and must present a satisfactory *thesis*. The diploma given indicates the line of study pursued. A time limit is not fixed; but four years is usually needed for the completion of the 130 hours of work.

Bachelors of Arts, of Philosophy, of Science, and of Letters, of this University, and graduates of any other reputable college, are excused from some portions of the general requirements, and are recommended for the same degree with the regular students upon completing the remaining requirements. This work can be done in two years. The culture imparted by classical or other liberal training will be found to have its uses for one engaged in engineering work, and previous discipline of the faculties in exact research will enable the professional student to master more easily the requirements of the course. All the time the student can devote to general studies before taking up specialties will be well spent.

A choice between the three courses in engineering need not be made before the end of the first year.

GENERAL REQUIREMENTS.

The *general requirements* are as follows:

In French and German: fifteen hours, viz: Courses A, B, C, in one language, and Courses D, E, in the other.
In English: Courses 1, 1*a*.
In Mathematics: Courses 1, 2, 3, 4, 6.
In Physics: Courses 1, 2.
In Chemistry: Course 2 or Course 3.
In Drawing: Courses 1, 4, 5.
In Shop Practice: Courses 1*a*, 2*a*.
In Civil Engineering: Courses 3, 5.
In Mechanical Engineering: Courses 2, 3.

SPECIAL REQUIREMENTS.

The *special requirements* in the several courses are as follows:

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*Students who entered the Department prior to the year 1897 will be allowed to graduate on completion of the courses prescribed at the time of their entrance. See the University Calendar for 1896–97, pages 142 to 144.

†For explanation of the term Hour of Credit see page 29, and for further information in regard to the courses prescribed for graduation, see pages 29 to 37.

1. *In Civil Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Civil Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Physics: Course 3*c*.
In Mineralogy: Course 1.
In Geology: Course 1.
In Astronomy: Course 4.
In Drawing: Course 14.
In Surveying: Courses 1, 2, 3, 5, 6.
In Civil Engineering: Courses 4, 6, 7, 8, 9.
In Mechanical Engineering: Course 15.
In Electrical Engineering: Course 4*b*.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

2. *In Mechanical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Mechanical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Physics: Course 3*c*.
In Surveying: Course 4.
In Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.
In Civil Engineering: Course 9.
In Mechanical Engineering: Courses 1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.
In Electrical Engineering: Course 4*b*.
In Metallurgy: Course 1.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

3. *In Electrical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Electrical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Physics: Course 3*b*.
In Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.
In Mechanical Engineering: Courses, 4, 5, 6, 7.

In Electrical Engineering: Courses 1, 2, 3, 4*a*, 5, 6, 7.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

A course of study which leads to the degree of Bachelor of Science in Chemical Engineering is now offered, as follows:

PROGRAM OF WORK FOR BACHELOR OF SCIENCE IN CHEMICAL ENGINEERING.

First Year:—The same for all students in this Department.

Second Year, First Semester:—German or French A, Beginner's Course, *three hours;* Physics 2, Heat, Electricity and Magnetism, *five hours;* Analytical Chemistry 1, Qualitative Analysis, *ten hours;* total, *eighteen hours.*

Second Semester:—German or French B, *three hours;* English 1*a*, *two hours;* Physics 3*c*, Laboratory, *three hours;* Analytical Chemistry 4, Quantitative Analysis, *seven hours;* total, *fifteen hours.*

Third Year, First Semester:—Mathematics 3, Calculus, *five hours;* Analytical Chemistry 10, Organic Chemistry, *five hours;* Analytical Chemistry 11*a*, Organic Preparations, *two hours;* Chemistry 31, Chemical Technology, *five hours;* total, *seventeen hours.*

Second Semester:—Mechanical Engineering 3, Dynamics of Machinery, *one hour;* French or German, *three hours;* Chemistry 32, Organic Technology, *five hours;* Electives [Mathematics 4, Calculus and Mechanics I, *five hours*]; total required, *nine hours.*

Fourth Year, First Semester:—Surveying 4, Use of Instruments, *one hour;* Metallurgy, 1, Fuels, Iron and Steel, *three hours;* Mechanical Engineering 2, Mechanism, *two hours;* Mechanical Engineering 6, Design of Machine Tools, *two hours;* Mechanical Engineering 7, Hydraulic Machinery, *one hour;* Analytical Chemistry 5, Advanced Quantitative Analysis, *five hours;* Electives [Mathematics 6, Calculus and Mechanics II, *four hours*]; total required, *fourteen hours.*

Second Semester:—Mechanical Engineering 4, Engines, Boilers, *two hours;* Electrical Engineering 4*b*, Dynamos, *three hours;* Analytical Chemistry 21, Gas Analysis, *one hour;* Special Chemistry, *five hours;* Thesis; total required, *eleven hours.*

Total number of exercises, 118; electives, 12; requirement for graduation 130 hours and a thesis.

It is recommended that students who intend to devote *five* years to this course take, in addition to the above required work, during the first four years, Mathematics 4 and 6, and Civil Engineering 5, Resistance of Materials. They will then, in their fifth year, be prepared to take work in Machine Design.

GRADUATE COURSES.

The Degree of Master of Science.

A candidate for the degree of Master of Science in this Department must have previously received the engineering degree of Bachelor of Science from this University, or, if graduated elsewhere, must satisfy the Faculty that he possesses equivalent attainments.

He must choose a *major* subject, which shall occupy one-half of his time, from the work given in this Department, and two *minor* subjects, each to occupy one-fourth of his time, to be selected from any work open to engineering students; all of the work, however, shall be subject to the approval of the Faculty. Study and residence for not less than one year will be required. The following subjects are now offered:

Civil Engineering.

FIRST SEMESTER.

11. Engineering Design, advanced. *Five hours.* Professor GREENE.
12. Water Supply and Sewerage. *Two hours.* Professor GREENE.

SECOND SEMESTER.

13. Economics of Railway Location. *One hour.* Professor GREENE.
14. Contracts and Specifications. *One hour.* Professor DAVIS.

Mechanical Engineering.

FIRST SEMESTER.

16. Heating and Ventilation. *Two hours.* Professor COOLEY.
    Course 16 must be preceded by Course 4.
18. Hydraulic Machinery. *Two hours.* Professor COOLEY.
    Couse 18 must be preceded by Course 7 or 15.
19. Gas Engines. *Two hours.*
    Course 19 must be preceded by Course 13.
20. Laboratory work. Advanced Course. *Two hours.*
    Course 20 must be preceded by Courses 9 and 11.

SECOND SEMESTER.

17. Compressed Air. Mechanical Refrigeration. *Two hours.* Professor COOLEY.
    Course 17 must be preceded by Course 13.
21. Specifications and Contracts. *One hour.*
    Course 21 must be preceded or accompanied by Course 14.

22. Thermodynamics. Advanced Course. *Three hours.* Mr. ALLEN. Course 22 must be preceded by Course 13.
23. Machine Design. Advanced Course. *Three hours.* Mr. FAIG. Course 22 must be preceded by Courses 10 and 12.

Physics and Electrical Engineering.

FIRST SEMESTER.

7. Electricity and Magnetism: Webster. *Three hours.* Junior Professor PATTERSON.
16. Theory of Heat: Preston. *Three hours.* Professor CARHART.

SECOND SEMESTER.

10. Electricity and Magnetism: Webster. *Two hours.* Junior Professor PATTERSON.
9. Alternate Current Phenomena: Steinmetz. *Two hours.* Professor CARHART.

If a candidate for the degree of Master of Science desires to have his work count towards the degree of Civil Engineer, Mechanical Engineer, or Electrical Engineer, as described below, the major subject must be taken in the course in which he took his bachelor's degree, and he must submit a satisfactory thesis before such degree as Engineer will be conferred.

The Degrees of Civil Engineer, Mechanical Engineer, and Electrical Engineer.

The conditions on which the degree of Civil Engineer, as an advanced degree, is conferred are as follows:

The degree of Civil Engineer may be conferred upon Bachelors of Science of this University, who have taken the degree for a course in civll engineering, if they furnish satisfactory evidence that they have pursued further technical studies for at least one year, and, in addition, have been engaged in professional work, in positions of responsibility, for another year. The first of the above requirements may be satisfied by pursuing at the University, under the direction of the Faculty, a prescribed course of study for an amount of time, not necessarily consecutive, equivalent to a college year. If the candidate does not reside at the University, his course of study must be approved in advance by the professor of civil engineering, and he must prepare a satisfactory thesis on some engineering topic, to be presented, together with a detailed account of his professional work, one month, at least, before the date of the annual Commencement at which he expects to receive the degree.

The conditions on which the degrees of Mechanical Engineer, and Electrical Engineer, as advanced degrees, are conferred upon Bachelors of Science of this University who have taken the degree for a course in mechanical engineering, or in electrical engineering, are analogous in character and in amount to those given above for the degree of Civil Engineer.

FEES AND EXPENSES.

Matriculation Fee.—Every student before entering any department of the University is required to pay a matriculation fee. This fee, which, for citizens of Michigan, is ten dollars, and for those who come from any other State or country, twenty-five dollars, is paid but once, and entitles the student to the privileges of permanent membership in the University.

Annual Fee.—In addition to the matriculation fee, every student has to pay an annual fee for incidental expenses. This fee is paid the first year of residence at the University, and every year of residence thereafter. Resident graduates are required to pay the same annual fee as undergraduates. The annual fee in the Department of Engineering is, for Michigan students, thirty-five dollars; for all others, forty-five dollars.*

The Matriculation Fee and the Annual Fee must be paid in advance. No portion of the fees can be refunded, except by order of the Board of Regents, to students who leave the University during the academic year. A by-law of the Board of Regents provides that no student or graduate shall be allowed to enjoy the privileges of the University until he has paid all fees that are due.

Fee for Special Entrance Examinations.—An applicant for admission who desires to take the entrance examinations at a time not announced is required to pay to the Treasurer a fee of five dollars before permission to take the examinations can be granted him.

Diploma Fee.—The fee for the diploma given on graduation is ten dollars, and the by-laws of the Board of Regents prescribe that no person shall be recommended for a degree until he has paid all dues, including the fee for diploma.

Laboratory Courses.—The required laboratory courses cost approximately as follows: *Shop Practice.*—In the mechanical and electrical engineering courses, thirty dollars. *Physical Laboratory.*—A charge of one dollar is made for a course requiring one exercise a week during one semester, and at the same rate for the longer courses. *Mechanical Laboratory.*—The charge for each course is five dollars. *Chemical Labora-*

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*An annual fee of ten dollars is required of all graduates who are granted the privilege of pursuing studies for an advanced degree *in absentia*.

tory.—Students who take laboratory courses in chemistry are required to pay for the materials and apparatus consumed by them. The average expense is about ten dollars.

The fee required for any course has to be paid before the work of the course is begun.

The total amount of fees paid to the University during the whole four years' course, for matriculation, incidental expenses, materials used and diploma, is, for Michigan students, from $185 to $210; and for others, from $240 to $265, varying more or less according to the student's actual laboratory expenses.

Other Expenses.—Students obtain board and lodging in private families for from three to five dollars a week. Clubs are also formed in which the cost of board is from one dollar and a half to two dollars and a half a week. Room rent varies from seventy-five cents to two dollars a week for each student. The annual expenses of students, including clothing and incidentals, are, on the average, about three hundred and seventy dollars. The University does not undertake to furnish manual labor to students; yet a few find opportunities in the city for remunerative labor.

There are no dormitories and no commons connected with the University. Students on arriving in Ann Arbor can obtain information in regard to rooms and board by calling at the Steward's office.

Students are temporary residents of the city, and, like all other residents, are amenable to the laws. If guilty of disorder or crime, they are liable to arrest, fine, and imprisonment. A rule of the University Senate provides that if a student is arrested, or is convicted by the civil authorities, he shall be cited to appear before the faculty of the department in which he is matriculated, and shall be liable to suspension or expulsion.

Register of Alumni.

The Announcement of this Department published in 1896 contains a Register of Alumni, from the graduates of 1860 to those of 1895 inclusive, and gives the positions held by them since graduation. Copies will be mailed on request until the edition is exhausted.

Students.

Resident Graduates.

NAME.	RESIDENCE.
Loomis Hutchinson, B.S.[E.E.], 1897,	*Ceresco.*
John Harold Montgomery, B.S.[E.E.], 1897,	*Ann Arbor.*
Joseph Stringham, B.S., E.M., *Michigan College of Mines*, 1895,	*Detroit.*

Undergraduates.*

NAME.	COURSE.	CREDIT.	RESIDENCE.
Emanuel Anderson,	M.	57	*Chicago, Ill.*
Leslie Douglass Anderson,		9	*Ishpeming.*
Emilio Arizpe,		4	*Saltillo, Mexico.*
James Chivis Armstrong,	E.	72	*Detroit.*
Frederic Everart Arnold,	M.	98	*Ann Arbor.*
George Ford Axtell,		8	*Ann Arbor.*
Norwood Brayman Ayers,	E.	60	*Omaha, Neb.*
Charles Wiley Baggott,	C.	94	*Ann Arbor.*
Benjamin Franklin Bailey,	E.	109	*Detroit.*
William Porter Baker,	E.	92	*Woodville, O.*
Wareham Strong Baldwin,			*Detroit.*
Clifford Aloysius Barabé,			*Negaunee.*
Frederic Crossgrove Barr,	E.	91	*Ann Arbor.*
Benjamin Warren Batchelder,		10	*Marinette, Wis.*
Frederick Paul Beach,	E.	104	*Lexington.*
Irving McCoullough Bean,	E.	42	*Milwaukee, Wis.*
Mark Brewer Beattie,	E.	41	*Ann Arbor.*
Elias Hyrum Beckstrand,		23	*Meadow, Utah.*

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* The letters in the column headed COURSE indicate the line of work the student has chosen to pursue; C denoting civil engineering; M, mechanical engineering; E, electrical engineering. As students are not asked to make choice of course until the beginning of their second year, the absence of a letter indicates that the student is in his first year, or, in a few cases, that he is taking miscellaneous studies without being registered as a candidate for any degree. The figures in the column headed CREDIT indicate the number of hours of work taken by candidates for degrees prior to the beginning of the current academic year, 1897-98, and completed without conditions, or credited to them on advanced standing. By an hour of work is meant the equivalent of one exercise a week for one semester.

Edward Lewis Benedict,	M.	25	*Birmingham.*
John Walter Frink Bennett,	C.	78	*Austin, Ill.*
Claude Kingsley Bentley,	E.	28	*Owosso.*
Frederic Adrian Bergbom,	M.	66	*Chicago, Ill.*
James Rowland Bibbins,	E.	69	*Detroit.*
Austin Perry Biggs,		10	*Ann Arbor.*
Clifford Allen Bishop,		8	*Quincy.*
August Emanuel Bjork,			*Chicago, Ill.*
Murray Blanchard,	C.	94	*Peru, Ill.*
Frederick King Boomhower,	E.	81	*Chateaugay, N, Y.*
Frederick Chittenden Borst,	M.	91	*Denver, Col.*
James Frederick Bourquin,			*Detroit.*
Charles Frederick Boyce,			*Port Huron.*
Walter Channing Boynton,	M.	45	*Detroit.*
Fred Norman Bradley,	M.	17	*Joliet, Ill.*
Thomas Alfred Bragg,	M.	96	*Grand Rapids.*
Fred Walter Brown,			*Flint.*
Irving J. Brown,	E.	85	*Niles.*
Roy Wilcox Brown,	E.	90	*Geneseo, Ill.*
Frederick Lewis Browne,	M.	67	*Bay City.*
Joseph Wallace Busch,	E.	53	*Marquette.*
John Winford Byers,	E.	102	*Grand Rapids.*
Charles Benjamin Campbell,			*Royal Oak.*
Herbert Ward Carpenter,			*Orion.*
George Moseley Chandler,	E.	73	*Chicago, Ill.*
Cornelius King Chapin,		25	*Lansing.*
Paul Cheever,	M.	37	*Ann Arbor.*
William Griswold Chesebrough,	M.	50	*Detroit.*
Clarence Howard Clark,		8	*Saginaw, West Side.*
Carlos Carleton Cleverdon,	M.	39	*Austin, Ill.*
James Walter Clift,	M.	77	*Washington, D. C.*
Stephen Prentis Cobb,	C.	37	*Kalamazoo.*
Harold Orange Comstock,	C.	58	*Owosso.*
Edwin Warren Conable,	C.	62	*Independence, Ia.*
Charles Olney Cook,	M.	109	*Detroit.*
Edward Bliss Coolidge,	E.	101	*Detroit.*
Sollace Burroughs Coolidge,	E.	92	*Detroit.*
William Lee Cooper,	M.	63	*Saginaw, East Side.*
Frederick James Corl,			*Louisville, Ky.*
Leonard Porter Coulter,	E.	94	*Ann Arbor.*
John Shepherd Cowgill,	E.	94	*Three Rivers.*
William Cowie,		8	*Detroit.*
William Henry Crago,		8	*Iron Mountain.*

Faust Franklin Crampton,	E.	112	*Monroe.*
Walter Turney Curtis,	C.	66	*Detroit.*
Henry Winter Daniels,	C.	80	*Ann Arbor.*
Ralph Emerson Darling,	E.	28	*Ann Arbor.*
Charles Baker Davis,	C.	7	*Ann Arbor.*
Burt J. Denman,	E.	71	*Toledo, O.*
Isaac DeYoung,	C.	106	*Chicago, Ill.*
Bartlett Chase Dickinson,	C.	74	*Kalamazoo.*
Harry Hammond Dickinson,	E.	30	*Nashville.*
Rollin Lawrence Drake,		3	*Coldwater.*
Paul Andrew Dratz,	E.	39	*Muskegon.*
John Hathaway Dressel,		60	*Kane, Ill.*
Walter Dwight Edgar,	E.	32	*Green Oak.*
Gustav Bernhard Eggert,		25	*Saginaw, East Side.*
John Adrian Elenbaas,			*Holland.*
Amos Floyd Everett,	C.	95	*Lansing.*
Philip Henry Falter,	C.	99	*Chicago, Ill.*
Howard Felver,	M.	96	*Batavia, Ill.*
David Gerould Fisher,	C.	37	*Kalamazoo.*
John Brewill Fisher,		8	*Detroit.*
Lucian Day Fite,			*Georgetown, O.*
Robert Myron Fox,	C.	96	*Detroit.*
Frederic Fridolph Fredlund,		9	*Ann Arbor.*
Frank Anton Fucik,	M.	94	*Chicago, Ill.*
John Milton Gibbs,			*Ishpeming.*
George Herbert Gibson,	E.	75	*Northville.*
Francis Fair Gillen,	C.	95	*Grand Haven.*
Leon Goldsmith,	E.	97	*Omaha, Neb.*
Ernest Payson Goodrich,	C.	106	*Ypsilanti.*
Henry Carlton Gowan,			*Sault Ste. Marie.*
Andrew Grabenstein,	C.	32	*Lake Linden.*
Lewis Merritt Gram,			*Menominee.*
Burdette F. Grant,			*Jackson.*
Fred May Green,	M.	94	*Charlevoix.*
Edwin Charles Hall, A.B., *Ripon College*,	C.		*Ripon, Wis.*
Œta M. Hall,		26	*Manchester.*
Omar Israel Hall,	M.	94	*Ann Arbor.*
Robert Morrison Hall,			*Three Rivers.*
Frederick Cyril Hannan,	C.	72	*Chicago, Ill.*
Burr Hardy,	M.	60	*Ann Arbor.*
Harry Eli Harrington,	E.	101	*Grand Rapids.*
Archie Lee Harris,	C.	66	*Orange,* Mass.

Emery Eugene Harris,			*Utica.*
Harmon Augustus Harris,	C.	62	*Chicago, Ill.*
Joseph Henry Harris,		5	*Kansas City, Mo.*
Sanford Frank Harris,	E.	62	*Chicago, Ill.*
Harry D. Harting,	C.	32	*Grand Rapids.*
Milton Charles Hartman,	E.	67	*Chicago, Ill.*
LeRoy Morton Harvey,	E.	101	*Oak Park, Ill.*
Orra Emmet Heffelbower,	C.	65	*Ann Arbor.*
James Hervey Herron,		12	*Erie, Pa.*
Walter Hugh Himes,		4	*Ann Arbor.*
Clinton Jerome Hixson,	E.	47	*Dnpont, Ohio.*
Stewart Hodges,			*Benton Harbor.*
Burt Bradley Hodgman,	M.	22	*Coldwater.*
Alpheus Elton Holcomb,		8	*Fenton.*
Percy Melvin Holdsworth,	M.	103	*Traverse City.*
Frederick Ruthrauff Hoover,	C.	49	*Kansas City, Mo.*
William Christian Hornberger,		8	*Lansing.*
James LeGrand Horth,		53	*Geneva, N. Y.*
Raymond Fuller Horton,			*Detroit.*
Lewis Glasgow Howlett,	E.	71	*Trinidad, Cal.*
Edwin Adolphus Hughes,	E.	70	*Elkhart, Ind.*
Harry Henry Hughson,			*Chicago, Ill.*
Floyd Byron Hull,		8	*Adrian.*
Henry Imhof,		8	*Chicago, Ill.*
Ernest Hiram Jacobs,	E.	39	*Owosso.*
Martin Oscar Johnson,			*Ishpeming.*
Herbert Arthur Johnston,	C.	51	*Kalamazoo.*
Edward Lindley Jones,			*Decatur, Ill.*
Chester Orville Jordan,			*Saint Joseph.*
Boleslaus Frank Kaminski,			*Detroit.*
Leo John Keena,			*Detroit.*
Edgar Weber Kiefer,		8	*Detroit.*
William Wick Kittleman, Jr.,			*Detroit.*
William Leasure Kimmel,	E.	57	*Ypsilanti.*
Alfred Henderson Knight,	M.	33	*Flint.*
Otto Adolph Krause,	M.	38	*Grand Rapids.*
Charles Augustus LaFever,	E.	60	*Battle Creek.*
Forest Henry Lancashire,			*Detroit.*
Frederick Ewbank Leefe,	C.	88	*Sault Ste. Marie.*
Charles Gillett Leeson,			*Manchester.*
Willy Lehnartz,	M.	56	*Grand Rapids.*
Ora Miner Leland,	C.	74	*Grand Haven.*
Ralph Garfield Lewis,	M.	20	*Ann Arbor.*

Alfred Emanuel Lindau,			*Chicago, Ill.*
Arthur Mayer Lindauer,		17	*Chicago, Ill.*
Bernard Haack Liskow,		12	*Saginaw, West Side.*
Claude Lyman Lockwood,			*Grand Rapids.*
Chester Brown Loomis,	M.	43	*Ypsilanti.*
Frank Irwin Louckes,			*Ann Arbor.*
Frederic Hale Loud,	C.	31	*Au Sable.*
Ernest Lunn,	E.	44	*Stanton.*
Guy Webster Lunn,	E.	44	*Stanton.*
Thomas Edward Lynch,			*Wiscoy, Minn.*
Thomas Lee Brent Lyster,		8	*Detroit.*
Robert Herman McCartney,			*Ishpeming.*
Andrew Horace McDougall,			*Ypsilanti.*
Walter Mac Gregor,	M.	35	*Bay City.*
George Edward McKana,			*Escanaba.*
William Meek McKee,	E.	67	*Chillicothe, O.*
Henry Archibald McLean,	M.	43	*Cass City.*
George D. McNaughton,	C.	35	*Sault Ste. Marie.*
Royal John Mansfield,	C.	63	*Bay City.*
Edward Potter Marsh,	M.	97	*Oak Park, Ill.*
William Jonathan Marsh,	E.	82	*Pittsford, N. Y.*
Carlos Efren Martinez,			*Saltillo, Mexico.*
Shigeru Matsuyama,	M.	49	*Tokio, Japan.*
Walter Ballard Maurice,	C.	32	*Detroit.*
Augustus Joseph Mayworm,	M.	63	*Detroit.*
Ezra Burton Mead,	M.	29	*Grand Rapids.*
Raymond Somers Mead,	E.	26	*Wiuona, Minn.*
Frederick Charles Mellish,			*Saginaw, East Side.*
Howard B. Merrick,	C.	94	*Wrightstown, Pa.*
William Lincoln Miggett,			*Massillon, O.*
William Cook Miller,	E.	39	*Ann Arbor.*
Herbert Albion Moody,	E.	94	*Biddeford, Me.*
Spencer Beach Moseley,			*Wauseon, O.*
John Theodore Mountain,	E.	64	*Chicago, Ill.*
Harrison Curtis Mower,			*Detroit.*
Melville Richard Moxley,	C.	22	*Saginaw, East Side.*
Ralph Macomber Myers,			*Muir.*
William Roy Nellegar,		12	*Chicago, Ill.*
Frederick Nelson Nelles,	M.	36	*Bay City.*
Howard Newcomb,			*Detroit.*
Fred Webster Newell, A.B., *Bates College*, A.M., *ibid.*,	E.	29	*Thetford, Vt.*
Claude George Newton,	C.	104	*Ann Arbor.*

Neil Ernest Nichols,			*Bay City.*
Clarence Warren Noble,	C.	80	*Ann Arbor.*
James Tainter Noble,	E.	50	*Rice Lake, Wis.*
Arthur Willcox Norton,	M.	28	*Chicago, Ill.*
Henry Hazard Norton,		24	*Howell.*
Casin Watson Obert,	M.	36	*Durand.*
Floyd J. Page,	M.	20	*Dexter.*
John Castelar Parker,		10	*Detroit.*
Parvin Nelson Pattison,		3	*Kansas City, Mo.*
Pierre Barbeau Pendill,		14	*Marquette.*
Oluf Gottlieb Petersen,	M.	32	*Ann Arbor.*
Joseph Herman Pettersch,	E.	95	*Grand Raptds.*
Mortimer R. Platt, Jr.,			*Kansas City, Mo.*
Arthur Wheeler Plum,	M.	32	*West Bay City.*
Edwin Porter,		12	*Chicago, Ill.*
Roy Ellis Potter,	E.	14	*Greenville.*
Otto Pruessman,	E.	110	*Chicago, Ill.*
Edward Hawks Ravenscroft,	C.	96	*Ravenswood, Ill.*
Porter Benson Rawson,			*Victor, N. Y.*
Clarence Webster Raynor,	C.	96	*Adrian.*
Ard Ezra Richardson,	M.	79	*Saginaw, East Side.*
Arthur Howard Richardson,		8	*Jackson.*
Donald Bennett Roben,		3	*Big Rapids.*
Wellington Roberts,	C.	50	*Sanlt Ste. Marie.*
Albert Francis Rogers,			*Ishpeming.*
David Nathaniel Rosen,	M.	68	*Muskegon.*
Eugene Albert Rummler,	M.	103	*Detroit.*
Richard William Runge,	E.	49	*Winona, Minn.*
Herbert Lafayette Russell,	C.	91	*Ann Arbor.*
Thomas Edsall Rust,			*Denver, Col.*
Andrew Oliver Rye,			*Ishpeming.*
James Thorpe St. Clair,	E.	91	*Ann Arbor.*
Herbert Lincoln St. John,		8	*Ann Arbor.*
Ross T. Sanford,			*Greenville.*
Frank Noble Savage,	C.	97	*Chicago, Ill.*
James Harvey Sawyer,	C.	73	*Ludington.*
Guy Burton Schiller,	E.	18	*Niles.*
Sylvester Ambrose Seabolt,		8	*Ann Arbor.*
Louis Ernest Seas,	C.	37	*Vicksburg.*
Harry Mix Sedgwick,	M.	24	*Chicago, Ill.*
Roie Claire Seery,			*Allegan.*
George Sewell,		6	*Detroit.*
Leonard Shaw,			*Detroit.*

Lloyd Bown Smith,	C.	92	*Paola, Kan.*
William Henry Spire,			*Ceylon.*
Harry J. Sproat,		3	*Grand Rapids.*
Clarence William Squier,	E.	109	*Ann Arbor.*
Robert Steck,	E.	107	*Chicago, Ill.*
John Frederick Streib,	C.	95	*Bucyrus, O.*
William Cornelius Swartout,		6	*Fenton.*
William Whitney Talman,	M.	15	*Detroit.*
Cary Davis Terrell,	E.	72	*Jackson, Miss.*
Charles Sydney Thomas,			*Towns, Ga.*
Claudius Horatio Thomas,	M.	90	*Detroit.*
John Eugene Thompson,	E.	19	*Ann Arbor.*
Ambrose Jacob Tower,	M.	36	*Greenville.*
Foster David Tower,	E.	20	*Greenville.*
Alva Frederick Traver,	M.	30	*Jackson.*
Howard Platt Treadway,	C.	100	*Grand Rapids.*
Frank Trott,	M.	68	*Muskegon.*
Harold Kleiny Turner,		8	*Saginaw, West Side.*
Sutton Van Pelt,	C.	128	*LaPorte, Ind.*
Richard Waldron, Jr.,		8	*Jackson.*
Joseph Jacob Walser,	C.	31	*Austin, Ill.*
Charles M. Waters,	C.	24	*Lawton.*
William Ashley Waugh,	M.	39	*Wellsburg, W. Va.*
Albert Andrew Weber,	M.	100	*Jackson.*
Charles Herman Weideman,	M.	65	*West Bay City.*
William Roe Weidman,		72	*Chicago, Ill.*
Walter Edward Welz,		11	*Detroit.*
James McMillan Wetmore,		8	*Detroit.*
Clarence Wright Whitney,	M.	77	*Traverse City.*
Bertram DeWitt Wilber,	E.	71	*Ypsilanti.*
Frederick J. Wilbur,			*Dowagiac.*
Burt Henry Winchester,		8	*Jackson.*
Arthur Bryant Wood,	E.	31	*Union City.*
Joseph Walter Wood,	E.	28	*Niles.*
Morey Aldrich Wood,	M.	98	*Battle Creek.*
Fay Woodmansee,	E.	86	*Ann Arbor.*
John Williams Woodruff,	M.	30	*Ludington.*
George Daniel Wuerfel,	M.	59	*Toledo, O.*
Bert Starr York,	E.	21	*Ann Arbor.*
Frederic Vespasian Young,		31	*Hastings.*
Claude Earl Young,	E.	21	*Corunna.*
Jacob George Young,	C.	43	*Atkins, Ia.*
Theodore Frederick Zealand,		4	*Jackson.*

UNIVERSITY OF MICHIGAN.

DEPARTMENT OF ENGINEERING

GENERAL ANNOUNCEMENT

AND

REGISTER OF ALUMNI

FOR

1899-1900

ANN ARBOR, MICHIGAN
PUBLISHED BY THE UNIVERSITY
1899

UNIVERSITY OF MICHIGAN.

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ANNOUNCEMENTS FOR 1899–1900.

1899.	
June 20.	Class Day.
June 21.	Alumni Day.
June 22.	Commencement in all Departments of the University.
June 23 to Sept. 25.	Summer Vacation.
June 28 to Aug. 10.	Summer School.
Sept. 21 to 23.	*Examination for Admission to the Department of Engineering.*
Sept. 26.	FIRST SEMESTER BEGINS IN ALL DEPARTMENTS OF THE UNIVERSITY.
Nov. —.	Thanksgiving recess of three days, beginning Tuesday evening, in all departments of the University.
Dec. 21.	(Evening). Holiday Vacation begins in all Departments.
1900.	
Jan. 9.	Exercises resumed.
Feb. 9.	(Evening). FIRST SEMESTER CLOSES.
Feb 12.	SECOND SEMESTER BEGINS.
April 13.	(Evening). Recess begins, ending April 23 (Evening).
June 21.	COMMENCEMENT IN ALL DEPARTMENTS OF THE UNIVERSITY.

THE COURIER PRINT,
ANN ARBOR, MICH.

Department of Engineering.

FACULTY.*

JAMES B. ANGELL, LL.D., PRESIDENT.

CHARLES E. GREENE, A.M., C.E., Professor of Civil Engineering, and Dean of the Department of Engineering.

WILLIAM H. PETTEE, A.M., Professor of Mineralogy, Economic Geology, and Mining Engineering.

ISAAC N. DEMMON, LL.D., Professor of English and Rhetoric.

MORTIMER E. COOLEY, M.E., Professor of Mechanical Engineering.

WOOSTER W. BEMAN, A.M., Professor of Mathematics.

CHARLES S. DENISON, M.S., C.E., Professor of Descriptive Geometry, Stereotomy and Drawing.

†HENRY S. CARHART, LL.D., Professor of Physics, and Director of the Physical Laboratory.

RAYMOND C. DAVIS, A.M., Librarian.

OTIS C. JOHNSON, PH.C., A.M., Professor of Applied Chemistry.

PAUL C. FREER, PH.D., M.D., Professor of General Chemistry, and Director of the Laboratory of General Chemistry.

JOSEPH B. DAVIS, C.E., Professor of Geodesy and Surveying.

ASAPH HALL, JR., PH.D., Professor of Astronomy, and Director of the Observatory.

ISRAEL C. RUSSELL, C.E., LL.D., Professor of Geology.

GEORGE A. HENCH, PH.D., Professor of Germanic Languages and Literatures, and temporarily in charge of the Department of Romance Languages.

CLARENCE G. TAYLOR, B.S., M.E., Professor of Mechanical Practice, and Superintendent of Shops.

EDWARD D. CAMPBELL, B.S., Junior Professor of Analytical Chemistry.

ALEXANDER ZIWET, C.E., Junior Professor of Mathematics.

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*In this list are included a few other officers and instructors with whom engineering students are likely to elect work.

†Absent on leave.

GEORGE W. PATTERSON, Jr., A.M., S.B., Junior Professor of Physics.

PAUL R. de PONT, A.B., B.S., Assistant Professor of French, and Registrar of the Department of Engineering.

JOHN O. REED, Ph.D., Assistant Professor of Physics.

JOSEPH L. MARKLEY, Ph.D., Assistant Professor of Mathematics.

GEORGE O. HIGLEY, M.S., Instructor in General Chemistry.

DAVID M. LICHTY, M.S., Instructor in General Chemistry.

CLARENCE G. WRENTMORE, B.S., Instructor in Descriptive Geometry and Drawing.

KARL E. GUTHE, Ph.D., Instructor in Physics.

ARTHUR G. HALL, B.S., Instructor in Mathematics.

JAMES W. GLOVER, Ph.D., Instructor in Mathematics.

LOUIS A. STRAUSS, Ph.M., Instructor in English.

EDWIN C. GODDARD, Ph.B., Instructor in Mathematics.

HERBERT J. GOULDING, B.S., Instructor in Descriptive Geometry and Drawing.

JOHN R. ALLEN, M.E., Instructor in Mechanical Engineering.

ALFRED H. WHITE A.B., Instructor in Chemical Technology.

CARROLL D. JONES, E.E., Instructor in Electrical Engineering.

JOHN E. LAUTNER, M.L., Instructor in German.

AUGUSTUS TROWBRIGE, Ph.D., Instructor in Physics.

COLMAN D. FRANK, Ph.B., Instructor in French.

WILLIAM H. BUTTS, A.M., Instructor in Mathematics.

ALBERT W. WHITNEY, A.B., Instructor in Mathematics.

ROBERT C. STEVENS, A.B., B.S., Instructor in Mechanical Engineering.

SHIRLEY W. SMITH, B.L., Instructor in English.

GEORGE L. GRIMES, B.S., Instructor in Mechanical Engineering.

ALICE L. HUNT, Assistant in Drawing.

FREDERICK J. WILBUR, Assistant in Astronomy.

ALFRED E. LINDAU, Assistant to the Dean of the Department of Engineering.

Special Assistants in the Engineering Shops.

ROBERT A. WINSLOW, Foundry.

JOHN M. SMOOTS, Iron Room.

HORACE T. PURFIELD, Wood and Pattern Room.

WILLIAM R. McDONALD, Forge Shop.

Department of Engineering.

GENERAL INFORMATION.

THE University of Michigan is a part of the educational system of the State, and derives from the State, in one way or another, the greater part of its revenue. The University comprises the Department of Literature, Science, and the Arts, and six professional schools, each of which has its own Faculty and issues each year a separate departmental announcement. The various faculties aggregated in 1898–9 one hundred and fifty officers of instruction, besides numerous assistants, some of whom participate in the work of teaching. Over three thousand students, representing nearly all the States and Territories, and many foreign countries, were in attendance.

In the legislative act under which the University was organized in 1837, provision was made for instruction in engineering. There are few older technical schools in the United States. Work was begun in this line in 1853, and the first degrees were conferred in 1860. The engineering courses were included in the Department of Literature, Science, and the Arts, until the close of the collegiate year, 1894–95. At that time the Department of Engineering was established by the Board of Regents.

Persons who wish to become professional engineers are offered here thorough courses in civil, mechanical, electrical, and chemical engineering. The work extends through four years. The aim of the Department is to lay a foundation of sound theory, sufficiently broad and deep to enable its graduates to enter understandingly on the further investigation of the several specialties of the profession; and at the same time to impart such a knowledge of the usual professional practice as shall make its students useful in any position to which they may be called. While the adaptation of theory to practice can be thoroughly learned only by experience, there are many matters in which the routine work of an engineering field party, office, or drafting room can be carried out on a greater or less scale in a training school. ***The technical branches are under the direct care of those who have had professional experience as well as a full scientific training***, and in all particulars the courses embody as close an imitation of the requirements of active labor as the instructors who have the several branches in charge can devise.

Attention is called to the Register of Alumni at the close of this Announcement; it is thought that the success of the graduates makes clear the satisfactory character of the work of the Department of Engineering.

The academic year extends from the Tuesday preceding the last Wednesday in September to the Thursday preceding the last Wednesday in June (September 26, 1899, to June 21, 1900).

REQUIREMENTS FOR ADMISSION TO THE DEPARTMENT OF ENGINEERING.

[For admission to advanced standing, see page 10.]

[For admission of students not candidates for a degree, see page 11.]

Candidates for admission must be at least sixteen years of age, and must present satisfactory evidence of good moral character. They must bring credentials from their last instructor, or from the last institution with which they have been connected.

Unless admitted on diploma from an approved school (see page 13), any student who desires to become a candidate for a degree must pass examinations in the subjects described below. Before entering upon the examination each applicant must present his credentials to the Dean of the Department at his office in the Engineering Building. Certificates and diplomas from schools other than those officially examined by the University, as specified on page 14, will not excuse an applicant from admission examinations.

Students who have satisfied any one of the four groups of requirements for admission to the Department of Literature, Science, and the Arts are admitted upon completing the requirements in Plane Trigonometry and in Chemistry. See page 9.

Admission of Candidates for a Degree.

The subjects on which applicants for admission to any of the courses leading to a degree in engineering will be examined are as follows:

English Language.—*Grammar.*—Selections for analysis and parsing will be set, arranged to test the applicant's knowledge of the leading facts of English Grammar. To meet this requirement, a review of the subjects should be had during the last year of the preparatory course.

Composition and Rhetoric.—The purpose of the examination in composition is to test the applicant's ability to write good English. To this end he will be asked to write two essays of not less than two hundred words each, one upon a subject drawn from books he has read, and the other upon a subject drawn from his experience or observation. The language of these essays must be grammatical and clear. The spelling, punctuation, and capitalizing must be correct. The applicant must show ability to discriminate in the use of words and to construct well-organized sentences and paragraphs. A topical outline should accompany each essay.

As preparation for this requirement, sustained and regular practice in writing is earnestly recommended. The student should prepare numerous written exercises throughout the four years of the high-school course, and a sufficient number of these exercises should be corrected by the teacher and revised by the student to secure the desired accuracy. The subjects upon which the student writes should not be drawn exclusively from literature; a considerable portion of them should be taken from the student's every-day experience; and topics should be so distributed as to give proper training in the various types of discourse, namely, description, narrative, argument, and exposition. The student should be grounded in the essentials of rhetoric, but those principles should receive emphasis which are most likely to be of service to him in his practice in writing, such as the principles of sentential structure, paragraphing, and the outlining of an essay. The correction of stock specimens of English is not recommended, and will form no part of the entrance requirement.

It is further recommended that the reading of English classics and the memorizing

of notable passages, both in prose and poetry, should form a regular exercise throughout the whole preparatory period. This is all-important for the development of a correct taste in language and literature.

The books, from which subjects for compositions will be chosen in the years named, are here given. The applicant should make himself familiar with the plot, incidents, and character of each work. Equivalents will be accepted.

1899. Chaucer's *The Knight's Tale*, or Dryden's *Palamon and Arcite;* Milton's *Paradise Lost*, Books I and II; Pope's *Iliad*, Books I, VI, XXII, and XXIV; The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* DeQuincey's *Revolt of the Tartars;* Cooper's *The Last of the Mohicans;* Lowell's *The Vision of Sir Launfal;* Hawthorne's *The House of Seven Gables.*

1900. Chaucer's *The Knight's Tale*, or Dryden's *Palamon and Arcite;* Milton's *Paradise Lost*, Books I and II; Pope's *Iliad*, Books I, VI, XXII, and XXIV; The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* DeQuincey's *Revolt of the Tartars;* Cooper's *The Last of the Mohicans;* McCauley's *Essay on Milton;* Burke's *Conciliation with the Colonies.*

1901–2. Shakespeare's *Merchant of Venice* and *Macbeth;* Milton's *Lycidas, Comus, L'Allegro, and Il Penseroso;* Burke's *Conciliation with the Colonies;* Macaulay's *Essays on Milton and Addison;* Pope's *Iliad*, Books I, VI, XXII, and XXIV; The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Coleridge's *The Ancient Mariner;* Scott's *Ivanhoe;* Cooper's *The Last of the Mohicans;* Tennyson's *The Princess;* Lowell's *The Vision of Sir Launfal;* George Eliot's *Silas Marner.*

English Literary History.—In addition to the books just named, it is expected that several other English classics will be read each year. These readings should be connected in reasonable measure, with the lives and characters of the authors read and with the history of their times. A good knowledge of the chronological order and of the leading characteristics of the principal modern English writers should be aimed at. Care should be taken not to overload the text of these classics with a mass of irrelevant and petty learning. Many of the "school classics" now in use are over-edited.

English Literature.—Daily recitations for at least one year will be requisite. Stopford A. Brooke's English Literature (edition of 1896), or any other manual, may be used for an outline of the subject. As much time as practicable should be given to the careful reading of representative authors in each period.

French, German, or Latin.—Applicants may offer French, German, or Latin, one of these three languages being required. It is expected that at least two years will be given to preparation in the language offered. The requirements in each are as follows:

French.—The whole subject of French Grammar. The applicant will be expected to read at sight easy French, and to translate correctly into French simple English sentences. The first year ought to be spent on the grammar and easy reading, and the second devoted to reading good modern French, accompanied by grammatical analysis and exercises in writing. The texts read should be chiefly narrative and conversational prose; modern, rather than classic, dramas should be read.

German.—(1) Ability to pronounce German correctly and to take part with reasonable correctness and facility in a simple conversation upon some topic drawn from the applicant's preparatory work. (2) Thorough familiarity with the every-day facts of the grammar, to be evidenced by putting illustrative English phrases into German. (3) Ability to translate at sight a passage of moderately difficult prose.

Advanced credit may be secured for one or two years of German or French study in excess of the two years required for admission.

Latin.—Jones's First Latin Book, on an equivalent amount in any other introductory text-book, four books of Caesar's Gallic War, and one of the orations of Cicero.

Mathematics.*—*Algebra.*—Fundamental Rules, Fractions, Simple Equations, Involution and Evolution, the Calculus of Radicals, and Quadratic Equations, as given in Olney's Complete School Algebra, or an equivalent in other authors.

Geometry.—Plane, Solid and Spherical Geometry as given in Beman and Smith's Plane and Solid Geometry, or an equivalent in other authors.

Trigonometry.—Plane Trigonometry as given in Olney's Elements of Trigonometry, or an equivalent in other authors.

N. B.—It is very desirable that High Schools whose graduates are received on diploma arrange their courses so as to include a portion of both algebra and geometry in their last preparatory year. Students who do not come from diploma schools should take a similar review if they expect to succeed in the study of mathematics in the University.

Physics.—An amount represented by Carhart and Chute's Elements of Physics. Laboratory work in physics is urgently advised, though not required; but students who have completed a course in laboratory practice may expect to derive advantage from it if they take work in the physical laboratory in the University (see page 33).

Chemistry.—The requirement is intended to cover one year's work. As a text-book, Freer's Elementary Chemistry, or an equivalent amount of work in Remsen's Introduction to the Study of Chemistry, is recommended. In either case the text should be accompanied by laboratory work.

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*Students entering at the beginning of the second semester (February 12, 1900) should be prepared in the mathematics of the first semester in addition to the other requirements for admission.

History.--General History as presented in such a work as Myers's General History, and one year's work in United States History and Civil Government. Johnston's History of the United States and Fiske's Civil Government or Hinsdale's American Government are recommended as text-books.

Botany, Physical Geography, or Astronomy.—The applicant may offer any *one* of these subjects. The requirements, intended to cover a half-year's work in each subject, are as follows:

Botany.—Laboratory work for half a year with occasional recitations and review exercises. The methods followed in Spalding's Introduction to Botany, or in Bergen's Elements of Botany, may serve to indicate the kind of work desired.

Physical Geography.—Tarr's Elementary Physical Geography, especially chapters 9 to 21 inclusive, or an equivalent.

Astronomy.—Newcomb and Holden's Astronomy, Briefer Course, Young's Elements of Astronomy, or an equivalent. A knowledge of the principal constellations is required.

Admission to Advanced Standing.

1. Graduates of the Department of Literature, Science, and the Arts of this University, or of any other reputable college, are admitted without examination to advanced standing as candidates for a degree in engineering, and are excused from a considerable portion of the general requirements for graduation (see page 46). The remaining requirements can be completed in two years, or, possibly, in a single year, if the student takes as electives, while an undergraduate, some of the courses open to him in the Department of Engineering. A knowledge of differential and integral calculus, of analytical mechanics, of elementary drawing, and of descriptive geometry, is needful for the advanced work.

2. Students who have completed at least one year's college work in an approved college, and who bring explicit and official certificates describing their course of study and scholarship, and testifying to their good character, are

admitted to advanced standing without examination, except such as may be necessary to determine what credit they are to receive for work done in the college from which they have come.

3. Students who have not completed a year's college work in an approved college, but, previous to entering this department of the University, have pursued studies beyond those required for admission, may be admitted to advanced standing on passing the regular entrance examinations, and examinations in such undergraduate studies as they may ask to be credited with in advance.

4. Rules relating to admission to advanced standing:

a. Any student whether a candidate for a degree or not, who applies for advanced standing on the conditions stated in paragraphs (2) and (3) above, must present to the Dean a statement showing the amount of work done in the subjects in which the credit is asked.

b. The application for advanced standing should be made to the Dean before the first of November, or (if the student be matriculated at the beginning of the second semester) before the fifteenth of March. The Dean will then furnish a blank form for presentation to the professors in charge of the several subjects named in the blank.

c. Credits must be secured before the fifteenth of December or (if the student be matriculated at the beginning of the second semester) before the tenth of April.

d. No credits will be given for advanced standing after the dates named in (*c*).

e. An account once closed cannot be reopened without special permission of the Faculty.

Admission of Students not Candidates for a Degree.

Persons who desire to pursue studies in this department, and do not desire to become candidates for a degree, are admitted on the following conditions:

1. All persons under twenty-one years of age must pass the regular entrance examinations.

2. Persons over twenty-one years of age must show that they have a good knowledge of English and are otherwise prepared to pursue profitably the studies they may desire to take up. Every applicant ought to have had the training received in a good high school, and a knowledge of algebra, geometry, trigonometry, physics, and chemistry, equivalent at least to that prescribed in the requirements for admission, will be necessary.

3. Should a student who enters under the preceding provision (2) subsequently become a candidate for graduation, he must pass the regular entrance examination, at least one year previous to the time when he proposes to graduate.

4. Students not candidates for a degree who wish credit for studies pursued before admission are referred to the rules relating to advanced standing given above.

5. Students not candidates for a degree are expected to attend the lectures, recitations, and examinations in the branches prescribed for the regular students, and are required to take enough work to occupy them profitably.

Time of Examination.

The examination for admission to the Department of Engineering will be held on Thursday, Friday, and Saturday, September 21, 22, and 23, 1899.* Applicants will not be examined at any other time except on payment of a special fee of *five dollars.*

As the examination begins at 8 A. M. on Thursday, it will be necessary for all applicants for admission on examination to present their credentials to the Dean of the Department, at his office, on Wednesday, September 20, between the hours of 9 and 5, and receive from him papers admitting to the examination.

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* The practice of holding an admission examination in June has been discontinued.

The examinations in the several subjects will be in writing and will be held in Tappan Hall in accordance with the schedule given below:

THURSDAY, SEPTEMBER 21.		TAPPAN HALL.
8 A. M.	Physics	Lecture Room
10 A. M.	History and Civil Government	Lecture Room
2 P. M.	Latin	Lecture Room
2 P. M.	German	Room 10
4 P. M.	Chemistry	Lecture Room
FRIDAY, SEPTEMBER 22.		
8 A. M.	Geometry	Lecture Room
10 A. M.	Botany	Lecture Room
10 A. M.	Physical Geography	Lecture Room
10 A. M.	Astronomy	Lecture Room
2 P. M.	Latin	Lecture Room
2 P. M.	French	Room 12
2 P. M.	German	Room 10
4 P. M.	Trigonometry	Lecture Room
SATURDAY, SEPTEMBER 23.		
8 A. M.	Algebra	Lecture Room
10 A. M.	English Literature	Lecture Room
2 P. M.	English	Lecture Room
4 P. M.	Chemistry	Lecture Room

Admission on Diploma.

Students presenting graduation certificates from any of the schools approved by the Faculty of the Department of Literature, Science, and the Arts, are admitted without examination to the Department of Engineering. The certificate from the school superintendent or principal, stating that the student has sustained his examinations in all the studies prescribed for admission to the Department of Engineering, or to any one of the courses offered in the Department of Literature, Science, and the Arts, and is recommended for admission to the University, must be presented to the Dean of the Department within a year and three months after graduation from the school, and the student must then begin his work.

If a certificate which would admit a student to the Department of Literature, Science, and the Arts shows any deficiencies in the requirements for admission to the Department of Engineering, such deficiencies must be made up, or substitutions secured from the Dean; extra studies may be credited on advanced standing, if the subjects are taught in either of the two departments.

The schools named below have been approved by the Faculty of the Department of Literature, Science, and the Arts, as qualified to prepare students for admission on diploma. Unless otherwise indicated, the places named are in Michigan, and the school approved is the public high school of the locality:

Adrian; Albion; Allegan; Alpena; Ann Arbor; Aurora, Ill.: East Side, West Side; Austin, Ill.; Battle Creek; Bay City; Belding; Benton Harbor; Benton Harbor Normal and Collegiate Institute; Big Rapids; Big Rapids: Ferris Industrial School; Birmingham; Bloomington, Ill.; Blue Island, Ill.; Buchanan; Burlington, Ia.; Cadillac; Calumet; Caro; Cassopolis; Cedar Rapids, Ia.; Champion; Charlotte; Cheboygan; Cheyenne, Wyo.; Chicago, Ill.: English High and Manual Training School, North Division, Northwest Division, South Division, West Division, Calumet, Englewood, Hyde Park, Jefferson High School, John Marshall School, Joseph Medill School, Lake, Lake View, South Chicago; Chicago, Ill.: Harvard School, Kenwood Institute, Lewis Institute, Princeton-Yale School; Chillicothe, O.; Cincinnati, O.: Hughes School; Cleveland, O.: Central High School, West High School, University School; Clinton, Ia.; Clyde, Ill.; Coldwater; Constantine; Corunna; Decatur; Decatur, Ill.; Delafield, Wis.: St. John's Academy; Denver, Col.: Manual Training High School; Detroit; Detroit: Detroit School for Boys, Home and Day School; Dexter; Dowagiac; Duluth, Minn.; Eaton Rapids; Elgin, Ill.; Elyria, O.; Erie, Pa.; Escanaba; Evanston, Ill.; Fenton; Flint; Fort Wayne, Ind.; Freeport, Ill.; Geneseo, Ill.; Gladstone; Golden, Col.; Goshen, Ind.; Grand Haven; Grand Haven: Ackley Institute; Grand Rapids; Greenville; Hancock; Harvey, Ill.; Hastings; Hillsdale; Holland; Holly; Houghton; Howell; Hudson: West Side; Indianapolis, Ind.; Indianapolis, Ind.: Classical School for Girls, Industrial Training School; Ionia; Iron Mountain; Ishpeming; Ithaca; Jackson: East Side, West Side; Joliet, Ill.; Jonesville; Kalamazoo; Kansas City, Mo.; Kendallville, Ind.; Lafayette, Ind.; La Grange, Ill. (Lyons township); Lake Linden; Lansing; Lapeer; LaPorte, Ind.; Leavenworth, Kan ; Ludington; Manistee; Mansfield, O.; Marine City; Marinette, Wis.; Marquette; Marshall; Mason; Maywood, Ill.; Menominee; Michigan City, Ind.; Midland; Milwaukee, Wis.: East Side, South Side, West Side; Moline, Ill.; Monroe; Mt. Clemens; Mt. Morris, Ill.: Collegiate Preparatory School; Mt. Pleasant; Muskegon; Nashville; Negaunee; New York, N. Y.: Berkeley School; Niles; Norway; Oak Park, Ill.; Omaha, Neb.; Orchard Lake: Michigan Military Academy; Otsego; Ottawa, Ill.; Owensborough, Ky.; Owosso; Paw Paw; Peoria, Ill.; Petoskey; Plainwell; Pontiac; Port Huron; Portland; Racine, Wis.; Racine, Wis.: Grammar School of Racine College; Richmond, Ind.; Rockford, Ill.; Rock Island, Ill.; Romeo; Saginaw: East Side, West Side; St. Clair; St. Johns; St. Joseph; St. Louis; St. Louis, Mo.: Hosmer Hall School; Smith Academy; Sandusky, O.; Sault Ste. Marie; Schoolcraft; Sioux City, Ia.; South Bend, Ind.; Springfield, Ill.; Sturgis; Tacoma, Wash.; Taylorville, Ill.; Tecumseh; Three Rivers; Toledo, O.; Traverse City; Troy, Union City; Wayne; West Bay City; West Des Moines, Ia.; Wyandotte; Ypsilanti.

THE WORK OF THE DEPARTMENT.

The studies pursued in the earlier part of the course comprise, in *Mathematics*, advanced algebra, analytic geometry, and the elements of differential and integral calculus; in *French* and *German*, an amount covering in all about a year and a half of study; in *English*, courses in higher English Grammar and composition; in *Physics* and *Chemistry*, studies of the principles; and in *Drawing*, practice in geometrical and in mechanical drawing, and in the study of descriptive geometry.

The more technical subjects are taken up in the latter part of the course. Some of these subjects are of equal value to all classes of engineering students, such as analytical and applied mechanics, the strength and resistance of materials, and the metallurgy of the useful metals, especially iron and steel; others are adapted more particularly to the wants of the special students in the several courses. Their general scope may be seen from the following descriptive outline.

DESCRIPTION OF COURSES.

Drawing.—A very complete course in mechanical drawing is given, embracing plane projection drawing, isometric drawing, descriptive geometry, and the elementary principles of coloring and shading, with original problems executed in the drawing-room. Examples from numerical data are always given when suited to the conditions of the problem in hand. Students in mechanical engineering are required to sketch pieces of machinery, and afterwards to make working drawings suitable for use in the shop. The plans of surveys, plane-table work, maps, designs in engineering construction, and the thesis drawings naturally come under this head. Instruction is also given in free-hand drawing, topographical drawing, ornamentation and lettering, shades and shadows, linear perspective, and drawing for stone cutting. The work in drawing occupies the student a part of almost every day throughout the course.

There are four large and well-lighted drawing-rooms, three of which are in the engineering building and one in the engineering laboratory. There are also special rooms for blue-printing and a dark room for photography.

Mechanical Practice and Shop Work.—The aim of the instruction in this department is to make the student, as far as time will permit, acquainted with the best mechanical practice; the instructors in all practical work are men of wide experience, selected for their mechanical skill; and the department attempts to keep in touch with the most improved methods of mechanical construction.

The courses of instruction all begin with a systematic series of graded and interferometer, a polarimeter from Schmidt & Haensch, besides many telescopes and valuable accessories for investigation in light.

The work in the physical laboratory is entirely quantitative in character. The apparatus includes, however, ample provision for illustrating the general principles and laws of physics in the lecture courses.

Chemical Laboratories.

The chemical laboratories provide for classes in general, analytical, organic, and physical chemistry, in pharmacy, in chemical technology, and in metallurgical assaying. They also provide for original research in the several branches of chemical science and for independent investigations. In the course of the year, classes are formed in forty-six distinct courses of study. In the greater number of these courses the method of work combines training in laboratory operations with instruction by lectures and conference, these methods being united in one course.

The chemical building contains in all about 37,000 square feet of floor space. Besides the rooms for recitations, storage, administration, etc., the laboratories for students have an area of about 25,000 square feet.

The laboratory of general chemistry is separately organized. Courses in elementary inorganic chemistry, as well as in physical chemistry and the advanced branches of the science are offered; research work both in inorganic and in organic general chemistry is also arranged for a limited number of students, and is carried on in a separate room. Modern apparatus is on hand for all the varieties of work that are liable to be undertaken, and a well equipped balance room is provided.

The laboratories of analytical chemistry, organic chemistry, pharmacy, and chemical technology, are carried on together. There are separate work rooms for qualitative analysis, quantitative analysis, iron and steel analysis, electrolytic work, pharmaceutical preparations, organic preparations, organic analysis, physiological chemistry, and assaying of ores,—as well as rooms for the weighing balances and instruments of precision, for gas analysis, and for optical work. There are eleven separate rooms for original research. The building contains two lecture rooms, two recitation rooms, and a museum with collections for instruction in chemistry, pharmacy, pharmacognosy, and chemical technology. In the ventilation of the work rooms the supply of fresh air is enforced by driving fans, and the removal of foul air is effected by strong draught flues, with which, also, work-hoods are connected.

The chemical laboratories are open throughout the college year to all students of the University, and are regularly used by the several departments. They are also open to any person who wishes to pursue special [illegible] therein, provided he complies with the conditions for admission to that department of the University to which the desired special studies properly belong.

Over three hundred students are engaged in these laboratories at the same time, each at a table provided for one worker. During the year, from 600 to 700 students complete from one to five courses of study each in the various branches of chemistry.

Engineering Shops.

The engineering shops are in a group of connected buildings, containing about 17,000 square feet of floor space devoted to shop work.

The *Wood and Pattern Shop*, 40 by 80 feet, is equipped with the tools and machinery usually found in a first-class establishment. One end of the shop contains the work-benches and the tools needed for hand work; the other contains a good variety of wood-working machinery, much of which was built in the shops. Above the wood-room a pattern-loft, 40 by 80 feet, contains a large collection of patterns made by students during the past few years.

The *Foundry*, 60 by 40 feet, is equipped with two iron cupola furnaces, one capable of melting six hundred pounds, and the other two tons, of iron an hour; two brass furnaces of a capacity of 150 pounds each; a modern core-oven; elevators; crane; blowers; and a supply of flasks and small tools adapted to the work to be done. A large part of this equipment was made in the shops.

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The central portion of the building, 32 by 54 feet, contains in the basement a well-ventilated wash-room, and on the first floor an engine room with a 10 by 30 Reynolds-Corliss engine, a storeroom and an office for the superintendent.

New machinery is added to each shop from time to time for the accommodation of engineering students and others desiring instruction and practice in the use of tools for working in wood and metal. Opportunity is afforded to become familiar with the more common materials and forms of construction used in engineering structures, buildings, and machinery. In all work an effort is made to follow the practice of the best shops.

transit and stadia; plane-table work; and surveying with aid of the camera, including the development of negatives and the printing and mounting of photographs. From the field notes and photographs maps are made by the student. In this connection, also, the student has practice in making blue prints from negatives and from drawings.

During the last month of the academic year the class is in camp as a field party. A survey is made for some line of communication, usually a railroad, including exploration, preliminary and located lines, easements to curves, profile levelling, check levels, profile making, cross-section data, cross-sectioning, transfer of line to plugs near grade points, witnessing, and, in general, the preparation of the line for construction up to the point of beginning excavation. In this connection good field and office records are required; profiles and maps are made; and the necessary computations, including those for earthwork quantities, are worked out.

In addition to the railroad survey some other piece of field work is undertaken, the selection being made according to the fitness of the locality, the number and the previous experience of the members of the class, the time, and the weather, the purpose being to fix, by practical application, the principles learned from text-book, lectures, or previous experience. Within the past few years work of the character indicated below has all been done, though not all in any one year:—small triangulation surveys, in which there is considerable reading of angles; compass surveys; shore-line surveys; surveys for special purposes, like town sites, bridge sites, cemeteries, or particular areas of unusual shape; resurveys of the United States Land Survey, including the finding and restoring of lost corners, and the subdivision of sections; contouring; hydrography; gauging of streams; levelling for special purposes, such as mill powers, lake levels, and the determination of the fall of streams; and, in general, any ordinary piece of field work, for which the locality chosen for the camp may afford favorable conditions.

The work in camp also includes office work along the various lines of field work, such as the computation of triangulations; reduction of careful measurements; calculation of earthwork, azimuth, areas, and elevations; mapping; platting; and profile-making.

(*b*) *For Students in Mechanical Engineering.*—The student in mechanical engineering takes a short course in the use of instruments, which is nearly all practice. He is required to read angles with a transit; to make a traverse; to make steel-tape measurements; to do simple levelling; and to compute and plat an enclosure survey. The aim of the course is to cover the simple manipulations in the ordinary use of surveying instruments, and to qualify the student for such duties in this line as are apt to fall to the mechanical engineer, such as mapping an enclosure, staking out a building and fixing the levels for it, laying out foundations for machines or boilers and establishing the levels for them, lining up shafts, setting water power machinery, and preparing lines for transmission of power by wire-rope, compressed air, or water.

(*c*) *Other Courses.*—Courses in Land Surveying, the United States Land Survey, the Canadian Survey, and in other specialties are provided, if properly qualified persons present themselves in sufficient number to form classes.

Geodesy.—For students prepared to undertake the work a course is offered, comprising lectures, reference reading, and written class reports, on geodetic methods in the field with special reference to successful present day practice. Some consideration is given to notable historical surveys, and constant use is made of reports and standard works of reference.

Highway Construction.—A short course, comprising lectures, text-book, and examinations, is given to students of civil engineering, on the construction and maintenance of roads, streets, pavements, and walks. References are made to existing examples and present practice. Byrne's Highway Construction is used as a text-book.

Municipal Engineering.—A course of lectures, prescribed reading, and recitations covers the special field of city engineering, points out its connection with, and dependence upon, other branches of engineering work, and shows how to apply the principles of engineering to the modern problems arising in the building and improving of cities. Among the topics treated are streets and their present uses, sewers, waterworks, public franchises, assessments, bridges, building inspection, fires, lighting, street cleaning, and garbage disposal. The instruction is not intended to be of a technical character, bur it aims to set forth the principles that should guide the city engineer in his relations to various matters of public concern, and to supplement and apply to this special field the instruction given in other courses. This course should not be taken by undergraduates before their last year of residence.

Strength and Resistance of Materials.—A course of recitations and lectures continuing through the first half-year is devoted to this subject, and is attended by all the engineering students except those pursuing the chemical engineering course. The action of the different materials under applied forces, the distribution of stress, and the proper proportions to be given to the different parts of structures in order that they may safely fulfil their several functions, are carefully studied. Greene's Structural Mechanics is used as a text-book.

Tests of wood, iron, steel, cement, and other building materials are made in the Engineering Laboratory.

Theory of Structures.—Roof and bridge trusses, in wood and iron, arches, in wood, iron, and stone; trestles; brick and stone masonry; foundations; tunnels; and, in general, the whole theory of structures are discussed. In this course Rankine's Civil Engineering is used as a text-book, supplemented by full explanations, additional notes, lectures, examples and problems, and illustrated by models, photographs, working drawings, and blue-prints.

A course of instruction extending through a year is also given in the graphical analysis of roof and bridge trusses and arches. The student is made familiar with both the analytical and graphical methods of treatment and thus possesses ready proof of the accuracy of his calculations. Greene's Roof Trusses, Bridge Trusses, and Arches are used as text-books.

Hydraulics.—The laws of the flow of water through orifices and pipes and over weirs; the gauging of streams and rivers; the designing of works for water supply, drainage, and sewerage; the laying out of canals; and the subject of river and harbor improvements are treated in this course. The text-book used is Merriman's Hydraulics.

Machinery, Prime Movers, and Millwork.—A course of instruction is given in mechanism, or the general principles of machinery, involving the study of gearing, screws, cranks, and levers, and the dynamics of machinery. In the study of prime movers, special attention is given to turbine and other water motors, and to steam engines. In the theory of machine construction, problems involving the strength and design of machines, and the materials used in their construction, and also involving the application of the principles of electricity, are studied at length in connection with such examples as illustrate the best practice. The instruction in millwork covers the distribution of power and the arrangement of shafting and machinery in manufacturing establishments. Practical problems involving the strength of shafting, belting, and gearing are fully treated. Tests are made to determine the efficiency of machines, and the value of lubricants.

Design of Shop Machinery.—The student is taught to design one or more of the standard machines used in shops. He is shown how to combine his theoretical and his practical knowledge so as to conform to the best mechanical practice. He designs one or more complete machines and makes a detailed drawing of each part for shop use. The drawings that possess merit and are carefully worked out are subsequently used in the shops. Instruction is also given in blue-print work. The course is intended in every respect to represent, as far as possible, the operations of actual business.

Designs in Engineering and in Machine Construction.—Contemporaneously with the study of theory students are required to work out problems in design. They are furnished with the usual data for a design, and the kind or type of structure or machine is indicated. They are then expected to make the necessary calculations, paying particular attention to proportioning the different parts so as to secure strength, simplicity and effect, and to present at a specified date complete working drawings, giving full details, accompanied by bills of materials, estimates, and specifications.

A course in **Thermodynamics** embraces the study of the principles governing the action of heat engines in general, hot-air and gas engines, air compressors, compressed-air engines, and refrigerating apparatus.

Steam Engineering.—The work in this branch covers the practical use of steam. Furnaces and boilers are studied with reference to proper combustion of fuel; to securing maximum evaporative efficiency; and to proportioning the parts for strength, durability, and accessibility for cleaning and repairs. The care and management of engines and boilers, both in use and out of use, are fully considered. A study is made of the principal steam pumps and pumping engines. The practical application of steam to heating and ventilating purposes is treated by lectures, and by inspection of actual plants. Tests are made to determine the value of fuels, quality of steam, and the efficiency of furnaces, boilers, and engines.

Marine Engineering and Naval Architecture.—The instruction in this branch comprises the study of marine steam engines and propelling instruments, the hydraulics of ship building, buoyancy, metacentre, stability and trim, weight and centre of gravity, waves and rolling, structural strength, speed and resistance, propulsion by sails and steam engines, laying-off and taking-on, and other topics.

Metallurgy.—A course of instruction by lectures and recitations is given upon the subjects of fuel, refractory material, iron, and steel. The lectures are illustrated by charts and drawings of furnaces and appliances used, and by samples of furnace products.

Primary and Storage Batteries.—A brief course combines theory and experimental work in measuring electromotive forces, polarization, internal resistance, and efficiency. Several types of storage cells are in constant use.

Electrical Measurements.—This course extends through an entire year and is devoted to practical work in the laboratory with the most modern apparatus. In addition to exact methods of measuring resistances, electromotive forces, and currents, it includes the calibration of the measuring instruments employed, the determination of capacity in absolute measure, the measurement of inductances, and the determination of the hysteresis curves of iron and steel.

Dynamo Electric Machinery.—The time given to this course is about equally divided between the study of the theory of generators and motors, and the determination in the electrical engineering laboratory of characteristic curves, of the series turns required to compound for constant potential, and the efficiency of generators and motors.

Alternating Current Machinery.—To the theoretical study of this subject is added laboratory work with alternators, transformers, and two-phase or three-phase transmission. Highly satisfactory machines have been built by electrical engineering students in the engineering shops.

Design of Electrical Machinery.—The course in electrical design gives the fundamental principles and illustrates them by numerical calculutions of electromagnets, of direct current machines, motors, alternators, and transformers. The lecture course is supplemented by exercises in drawing in which each student makes working drawings to accompany his own designs.

Industrial Chemistry.—Under this head come those courses which treat of chemical processes on a manufacturing scale. The chief subjects are: Fuels; water; the acid, alkali, cement, and glass industries; by-products from coal and wood; starch, glucose, and sugar; fermentation and distillation; fats, oils, and soap; bleaching and dyeing; tanning; the paper manufacture, etc.

Chemical Engineering.—This course is designed to meet the demands of manufacturers for men capable of intelligently directing manufacturing processes and handling machinery. To this end sufficient chemistry is introduced into the course to enable the graduate to act as his own chemist on most occasions. The instruction includes thorough laboratory drill in qualitative and quantitative analysis, courses in organic chemistry, chemical technology, metallurgy, and a special laboratory course in connection with some chosen manufacturing industry.

The engineering studies are, in the main, those required for the course in mechanical engineering; the student gains a knowledge of the construction and use of machinery, besides practical drill in the drawing rooms and shops; but the chemical studies indicated above take the place of the advanced mathematics and the higher work in engineering design.

By a proper selection of elective studies, and an additional year of college work, the graduate in chemical engineering can secure the degree of Bachelor of Science in mechanical engineering.

Visits of Inspection.—As often as practicable, visits are paid to neighboring manufacturing establishments, and to electric light and electric power stations, for the purpose of acquiring a knowledge of the methods employed in building, in the construction of bridges, machinery, and ships, and the best practice in electrical manufacturing and engineering on a large scale.

Examinations.

Examinations, usually in writing, are held at the end of each semester, but the classes are liable to be examined at any time, without notice, on any portion of their previous work.

FACILITIES FOR INSTRUCTION.

The collections for illustrating the instruction given comprise models, drawings, photographs, lithographs, and blue prints representing trusses, arches, and details of construction in iron, wood, and stone; also shapes of iron, working models of turbines and engines, and working drawings of a number of bridges. These collections are receiving additions from year to year, by gift and purchase, and are invaluable to the student.

Tests of engines and boilers, and of machinery in general, will be made on request, and the profit of such work devoted to extending the facilities of the engineering laboratory. The data of all experiments and tests made are kept in the laboratory records. Tests of materials are also conducted for private parties, and reported upon when desired.

All the laboratory work is on a practical basis, and is done as nearly as possible as it would be done in any well arranged manufacturing establishment. There is a metallurgical laboratory connected with the chemical laboratory, amply supplied with assay furnaces and other appliances. The latest and best books on professional subjects are added yearly to the library, where they are accessible to all; and frequent references are made to them in the class room as the various subjects are brought forward.

Physical Laboratory.

The ground floor of the physical laboratory is devoted to the experimental work in electricity and magnetism. All of this work is open to students in physics.

On the first floor are a commodious lecture room, an apparatus room, a large general laboratory for the elementary practical courses, a balance room, one room for advanced work in sound and light, and two private rooms.

In addition to the large collection of appliances for electrical measurements, the laboratory is supplied with the best apparatus in other lines from the most celebrated makers. In sound it includes tuning forks, resonators and special apparatus from Koenig, of Paris; in light, an ophthalmo-spectroscope from the Geneva Society, an optical bench with numerous accessories from Duboscq, a Zeiss focometer, spectrometer, and interferometer, a polarimeter from Schmidt & Haensch, besides many telescopes and valuable accessories for investigation in light.

The work in the physical laboratory is entirely quantitative in character. The apparatus includes, however, ample provision for illustrating the general principles and laws of physics in the lecture courses.

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Engineering Laboratory.

The *Engineering Laboratory*, 40 by 80 feet, is devoted to experimental work in connection with the testing of engines, boilers, pumps, indicators, belting, gearing, lubricants, and strength of materials, and to such original work as can be undertaken with advantage. The work also extends to the testing of engines, boilers, and water-wheels of neighboring mills and electric plants. The Knowles and the Gordon pumping engines at the City Water Works have been fitted up by the company with especial reference to the convenience of engineering students in making tests. The equipment contains, among other things, a 100,000-pound Olsen testing machine; a 2,000-pound cement testing machine; Thurston and Ashcroft oil testing machines; a Stirling boiler for high pressure; a high speed automatic engine; a Corliss engine; a Rider hot-air engine; Wheeler and Wainright surface condensers; an Alden absorption dynamometer; a Giddings traction recording dynamometer; an Emerson power-scale; several other forms of dynamometers; a large, electrically driven chronograph, built in the laboratory; a 36-foot open mercury column; special apparatus for testing pressure and vacuum-gauges and indicator springs; gauges; indicators; thermometers; pyrometers; tachometers; standard weights; steam pumps and injectors; rotary and centrifugal pumps; water meters; water motors, including a special universal water motor, built in the laboratory, together with pressure tanks and pumps for testing motors; hydraulic rams; water-wheels; air-pumps; blowers; apparatus for making tests on radiators and pipe coverings; apparatus for furnace gas analysis; a street railway motor; and other apparatus having special reference to work of investigation.

Electrical Laboratory.

The entire ground floor of the physical laboratory is devoted to experimental work in electricity. The rooms for electrical measurements contain solid stone-capped piers, and currents under a pressure ranging from 2 to 220 volts are available.

The laboratory is supplied with apparatus from the best American and European makers. It contains galvanometers and resistance boxes from Hartmann & Braun, Eliott Brothers, Nalder Brothers & Co., Queen & Co., and Willyoung & Co.; a series of ammeters and voltmeters from the Weston Co., for both direct and alternating currents; also wattmeters, condensers, electrodynamometers, electrostatic voltmeters, three Kelvin balances, standard cells, standard resistance coils, standard condensers, and an Ayrton & Perry standard of self-inductance.

In the dynamo room are two 10-light arc machines, two constant potential machines, and a 33 K. W. composite wound alternator made for the University by the Fort Wayne Electrical Corporation. These are all run from a counter shaft which is driven by a 50 H. P. 220-volt motor made by the Excelsior Electric Co. In addition, a small alternator for single phase, two-phase, or three-phase experimental work is run by a separate motor. Arc lamps, banks of incandescent lamps, resistances, rheostats, transformers and storage batteries complete the equipment. The transformers include a set for conversion from two-phase to three-phase transmission and the reverse. A well equipped photometric room adjoins the dynamo room.

The new University lighting plant, consisting of two 75 K. W. Thompson-Ryan generators and one 25 K. W. Westinghouse generator, is available for instruction in the department. The two large machines are connected by the Arnold system to two 15x14 engines and run at a speed of 250 revolutions per minute. The Westinghouse machine is directly connected to a Russell 9x12 automatic engine running at 300 revolutions per minute. The latter is located at the hospitals. These may be lighted independently, or may be supplied with current from the central plant on the campus by means of heavy mains and a "booster." The system is a 220-volt one throughout, with both incandescent and arc lamps (two in series) on the same circuits. All the feeders and mains are underground, except those running from the central plant to the hospitals and to the observatory.

The Arnold system permits of connecting either dynamo to either engine, or of disconnecting either so that it may be tested for efficiency by purely electrical methods. A large number of motors, varying in capacity from 1 to 50 H. P., are in service, and are available for testing purposes.

Astronomical Observatory.

The observatory is known as the Detroit Observatory, having been founded through the liberality of citizens of Detroit. Valuable additions and improvements have been made by contributions from several sources. The building consists of a main part, with a movable dome, and two wings. The meridian circle in the east wing was constructed by Pistor & Martins, of Berlin. In the main part are mounted clocks by Tiede and Howard. The west wing contains the observatory library, which connects with the residence of the Director. The refracting telescope, mounted in the dome, has an object glass thirteen inches in diameter. It was constructed by the late Henry Fitz, of New York.

A small observatory near the main building is used in the work of instruction. It contains an equatorial telescope of six inches aperture, and a transit instrument of three inches aperture, with zenith telescope attachment. A certain amount of practice in determination of time, latitude and longitude is required of all civil engineering students.

Geological Laboratory.

Opportunity for practical work in geology is provided in rooms set apart for this use in the Museum building. The rooms are furnished with microscopes, photographic instruments, cutting and polishing lathes, and other apparatus for the preparation of specimens. Special encouragement and assistance are given to students wishing to carry on original investigations.

The Libraries.

The various libraries of the University contain about 123,000 volumes, and include a number of important special collections. The portion devoted to engineering contains the standard works in this department of science, and the files of important society proceedings and professional periodicals. Seven hundred and forty periodicals are received.

The catalogue of the library is the usual card catalogue of authors and subjects.

Members of the faculties and other officers of the University may draw books from the library, subject to certain restrictions. To all other persons it is a reference library. The reading room for general use will seat 210 readers. Separate rooms are provided for advanced students where work is pursued with the necessary books at hand.

The library is open for consultation fourteen hours daily during the academic year, nine hours daily during the six weeks of the Summer School, and six hours daily from the close of the Summer School until the end of the summer vacation. The only exceptions to the above are Sundays and legal holidays.

The Engineering Society.

Several organizations of students are maintained, aside from the usual literary societies, for the reading of papers and holding discussions in various scientific lines. The Engineering Society, composed of and officered by students of this department, holds weekly meetings, at which papers of technical interest are read, and reports made upon observation and experiments. A reading room is maintained by the Society, accessible to all students of the department. Several engineers of prominence have spoken before the Society the past year. An annual, called the Technic, containing papers read before the Society, abstracts of theses, contributed articles from alumni, and other matters of professional interest, is published by the students.

The Summer School.

The Summer school, in session from June 28 to August 9, 1899, affords opportunity for study in languages, history, mathematics, natural, physical and applied science, and for work in the drawing rooms and laboratories. Students who wish to review studies preparatory to presenting themselves for examination for admission to the Department of Engineering will find courses directly adapted to meet their wants. A special Announcement can be had by addressing Mr. James H. Wade, Steward of the University.

Facilities for Physical Culture.

Waterman Gymnasium.—The University is provided with an excellent Gymnasium which has cost about $65,000. The main floor, which is a rectangle with truncated corners and dimensions of 150 by 90 feet, is well equipped with the various kinds of apparatus usually found in the best modern gymnasiums. A number of smaller rooms are devoted to administration, fencing, boxing, and other special purposes, while the basement is given up to baths and lockers. The main hall is lighted in the daytime by means of a large skylight 60 feet above the floor and in the evening by electricity. A gallery makes room for an elliptical running-track 375 feet in length.

In the conduct of the gymnasium the aim is not so much the development of a few gymnastic experts as the provision of wholesome physical exercise for the many. Attendance twice a week is required of all first year students. The facilities of the building, including physical examinations and instruction, are free to all students, the only charge being a rental of $2 a year for a locker.

An athletic field of ten acres has been set apart and equipped for open air sports. Room is also provided for tennis courts. Foot-ball and base-ball are practiced by class and University teams.

The Laboratories.

For a full account of all the laboratories and their various resources, as also of the University collections for the study of art, archeology, ethnology, mineralogy, paleontology, systematic zoology, etc., consult the annual Calendar, which may be had gratis on application to Mr. James H. Wade, Steward of the University. Those laboratories closely connected with the Department of Engineering are described in the preceding pages.

University Organizations.

An attractive series of lectures and musical entertainments is provided each year at a low price by the Students' Lecture Association. The Choral Union is an organization of students and others for the study and practice of choral music. A course of concerts and a festival of three days in May are announced under its auspices each year.

The Oratorical Association fosters an interest in oratory, and its members have been remarkably successful in recent contests.

COURSES OF INSTRUCTION.

The Courses of Instruction are subject to change from time to time; those announced for the year 1898–99 and required for graduation, as stated on pages 45 to 47, are described below, together with some advanced elective and technical courses, which are designated accordingly. The amount of credit towards graduation assigned to each course is indicated by the expressions *one hour*, *two hours*, etc., an *hour of credit* being given for the satisfactory completion of work equivalent to one exercise a week during one semester. Lectures and recitations are usually one hour in length, but in laboratory work, drawing, and other practical exercises, a longer attendance is required in order to secure an hour of credit.

The courses given in the Department of Literature, Science, and the Arts, are (with the exception of the courses in French and in German, for which special permission is required) all open as electives to engineering students who are qualified to pursue them with advantage.

Students will be classified and assigned to sections by a committee of the Faculty.

Rules and Regulations.

The work of students must be arranged in conformity with the following regulations:

a. Before entering on any study the student must give the instructor satisfactory evidence that he is prepared to pursue it with advantage.

b. No student will be allowed to elect merely a part of a course, without special permission of the Faculty.

c. No credit will be allowed to a student for work in any course, unless the election of the work is formally made and reported to the Registrar before the work is begun.

d. After the first Saturday of each semester no study can be taken up or dropped without special permission of the Faculty. All requests for permission to take up or drop studies must be made in writing on specially provided blank forms and in accordance with the rules printed thereon.

e. The Faculty requires a student to drop a part of his work at any time, if in its opinion he is undertaking too much; or to take additional work, if it thinks he is not sufficiently employed.

f. The Faculty reserves the right to withdraw the offer of any study not chosen by at least six persons.

g. In cases of exceptional proficiency, permission to take hours in addition to those named in the published schedule is granted by the Faculty on special request; but in all cases requests for permission to take an additional number of hours must be made in writing on a blank form provided by the Dean, and must be deposited in the Dean's box on or before the *first Saturday* of the semester during which the additional work is desired. No permission to take extra hours will be granted to students in their first semester of residence.

h. After matriculation, a student cannot, without special permission of the Faculty, be admitted to examination in any one of the courses given, until he has received in the University the regular instruction in such course.

French.

FIRST SEMESTER.

A. Beginners' Course. *Three hours.* Mr. FEANK.
C. Descriptive Prose. *Three hours.* Mr. FRANK.
D. Scientific Reading. *Three hours.* Mr. FRANK.

SECOND SEMESTER.

B. Narrative Prose. *Three hours.* Mr. FRANK.
E. Current Scientific Literature. *Three hours.* Mr. FRANK.

German.

FIRST SEMESTER.

A. Elementary Course. Thomas's German Grammar, and a German Reader. *Three hours.* Mr. LAUTNER.
C. Descriptive Prose. *Three hours.* Mr. LAUTNER.
D. Scientific Reading. *Three hours.* Mr. LAUTNER.

SECOND SEMESTER.

B. Elementary Course, continued. *Three hours.* Mr. LAUTNER.
E. Scientific Reading, continued. *Three hours.* Mr. LAUTNER.

English.

FIRST SEMESTER.

1. Paragraph Writing. *Two hours.* Mr. SMITH.

SECOND SEMESTER.

1*a*. Theme Writing. *Two hours.* Mr. SMITH.

Mathematics.

Students of engineering are required to take in order Courses 1, 2, 3, 4 and 6. They are also required to take Course 1*b*, unless they have passed a satisfactory examination for admission in plane trigonometry, but no credit toward graduation is given to engineering students for Course 1*b*.

FIRST SEMESTER.

1. Algebra and Analytic Geometry (I). *Four hours.* Mr. HALL, Mr. GODDARD, Mr. BUTTS, and Mr. WHITNEY.

1*b*. Plane Trigonometry. *Two hours.* Mr. WHITNEY.

3. Calculus. *Five hours.* Assistant Professor MARKLEY, Mr. HALL, and Dr. GLOVER.

6. Calculus and Mechanics (II). *Five hours.* Mr. HALL and Dr. GLOVER.

SECOND SEMESTER.

2. Analytic Geometry (II). *Four hours.* Mr. HALL, Mr. BUTTS and Mr. WHITNEY.

4. Calculus and Mechanics (I). *Five hours.* Assistant Professor MARKLEY, Mr. HALL and Dr. GLOVER.

Physics.

FIRST SEMESTER.

2. Heat, Electricity, and Magnetism. Lectures and recitations. *Five* hours. Professor CARHART.

   Course 2 must be preceded by Course 1 and a course in general or in analytical chemistry.

3. Physical Laboratory Work for Beginners. This course may be elected as 3*a*, *three hours;* or 3*b*, *two hours.* Assistant Professor REED and Dr. TROWBRIDGE. Fee: for Course 3*a*, $3 for 3*b*, $2.

Course 3 is also given in the second semester. It must be preceded or accompanied by Course 1. Students presenting notebooks from High School physical laboratories approved by this department, by electing Course 3*a*, may be allowed ***three hours*** of credit for ***two hours*** of work.

7. Mathematical Electricity and Magnetism. *Three hours.* Dr. TROWBRIDGE. (Elective.)

Course 7 must be preceded by Course 2. A knowledge of calculus is required.

8. Heat. Laboratory work. *Two hours.* Dr. GUTHE. (Elective.)

Course 8 must be preceded by Course 2. Fee. $2.

9. Theory of Heat: Preston. *Two hours.* Dr. GUTHE. (Elective.)

SECOND SEMESTER.

1. Mechanics, Sound and Light. Lectures and recitations. *Five hours.* Assistant Professor REED.

For Course 1 a knowledge of plane trigonometry is indispensable.

3. Physical Laboratory Work for Beginners. This course may be elected as 3*a*, *three hours;* 3*b*, *two hours.* Assistant Professor REED and Dr. TROWBRIDGE. Fee: for Course 3*a*, $3, for 3*b*, $2.

See note to course 3 in first semester.

3*c*. Laboratory Work in Mechanical and Electrical Measurements. *Three hours.* Dr. GUTHE and Mr. JONES. Fee, $3.

Course 3*c* must be preceded by Course 2. It is designed for students who wish to prepare for the study of dynamo-electric machinery.

10. Mathematical Electricity and Magnetism. *Two hours.* Dr. TROWBRIDGE. (Elective.)

Course 10 must be preceded by Course 7.

16. Theories of Solutions, Electrolytes, and the Voltaic Cell. Lectures and laboratory work. *Three hours.* Dr. GUTHE. (Elective).

Course 16 must be preceded by Course 2 in electrical engineering and by Course 1 in chemistry. It is also desirable that the student have had laboratory work in chemistry. Fee $1.

General Chemistry.

FIRST SEMESTER.

1. Elementary Inorganic Chemistry. Experimental lectures and recitations. *Three hours.* Mr. HIGLEY.

EITHER FIRST OR SECOND SEMESTER.

2. Laboratory Work in General Inorganic Chemistry. *Three or more hours.* Mr. HIGLEY and Mr. LICHTY.

   Course 2 must be preceded or accompanied by Course 1 or an equivalent. It is supplementary to Course 1 and covers in the laboratory the ground covered by lectures in Course 1.

Analytical Chemistry and Organic Chemistry.

FIRST SEMESTER.

1. Qualitative Analysis. Recitations and laboratory work. *Ten hours.* Professor O. C. JOHNSON and Mr. BROWN.

3. First Steps in Qualitative analysis. Recitations and laboratory work. *Five hours.* Professor O. C. JOHNSON.

   Course 3 is continued in Course 3*a* in the second semester, and the two Courses, 3 and 3*a* together, are equivalent to Course 1.

5. Advanced Quantitative Analysis. Laboratory work. *Five hours.* Professor E. D. CAMPBELL.

10. Organic Chemistry. Lectures and library studies. *Five hours.* Professor PRESCOTT.

   Course 10 must be preceded by Course 1 or 3.

11. Organic Preparations. Laboratory work. *Two hours.* Dr. GOMBERG.

   Course 11 must be preceded or accompanied by Course 10.

31. Chemical Technology. A study of chemical manipulations and reactions on a manufacturing scale. Fuels, water, the acid and alkali industries, cements, glass, and the destructive distillation of coal and wood with recovery of by-products. Lectures and assigned reading. *Five hours.* Mr. WHITE.

   Course 31 must be preceded by Course 1 or 3*a*.

SECOND SEMESTER.

3. First Steps in Qualitative Analysis. Recitations and laboratory work. *Five hours.* Professor O. C. JOHNSON.

3*a*. Qualitative Analysis in continuation of Course 3. Recitations and laboratory work. *Five hours.* Professor O. C. JOHNSON and Mr. BROWN.

   Courses 3 and 3*a* are together equivalent to Course 1 and cover the same ground.

4. Quantitative Analysis. Beginning course. Recitations and laboratory work. *Seven hours.* Professor E. D. CAMPBELL.

   Course 4 is open to those who have taken Course 1 or 3*a*.

32. Organic Technology. The industrial chemistry of organic compounds. Starch, glucose, and sugar; fermentation and distillation; fats, oils, and soaps; bleaching and dyeing; tanning; paper making; etc. Lectures and assigned reading. *Five hours.* Mr. WHITE.

Course 32 must be preceded by Courses 10 and 31.

34. Special Chemistry. Work selected from the advanced courses offered in the Department of Literature, Science, and the Arts. *Five hours.* Professor E. D. CAMPBELL.

Metallurgy.

FIRST SEMESTER.

1. Fuel and Refractory Material, Iron and Steel. *Three hours.* Professor E. D. CAMPBELL.

Course 1 must be preceded by Course 1 or 3 in analytical chemistry, or by Course 1 in general chemistry.

2. Micro-Metallography. The study of the microscopic structure of metals as related to their physical and chemical properties. Laboratory work with reading. *One hour.* Professor E. D. CAMPBELL. (Elective.)

Course 2 is open only to those who have taken Course 1, and who receive special permission.

Astronomy.

FIRST SEMESTER.

3. Spherical Astronomy, elementary course, with exercises in computing. *Two hours.* Professor HALL. (Elective.)

EITHER FIRST OR SECOND SEMESTER.

4. Practical Astronomy. Use of sextant and transit. *Three hours.* Professor HALL.

Course 4 requires a knowledge of spherical trigonometry and of differential and integral calculus.

SECOND SEMESTER.

13. Theory of Least Squares. *Two hours.* Professor HALL.

Mineralogy.

EITHER FIRST OR SECOND SEMESTER.

1. Lectures and practice. *Two hours.* Professor PETTEE.

For Course 1 an elementary knowledge of chemistry is desirable.

Geology.

SECOND SEMESTER.

12. Dynamical, Structural and Physical Geology. Text-book, lectures, and short thesis. *Three hours.* Professor RUSSELL.

Drawing.

FIRST SEMESTER.

1. Geometrical Drawing. *Two hours.* Mr. GOULDING.
4. Free-Hand Drawing; Pencil Drawing; Pen and Ink Drawing; Sketching. *Three hours.* Professor DENISON, Mr. WRENTMORE, and Miss HUNT.
10. Continuation of Course 8. *Two hours.* Professor DENISON and Miss HUNT. (Elective.)

    Course 10 must be preceded by Courses 4, 7 and 8.
13. Water-Color Drawing. *Three hours.* Professor DENISON and Miss HUNT. (Elective.)

    Course 13 must be preceded by Course 8. It can be taken only by special permission.

SECOND SEMESTER.

5. Descriptive Geometry. Recitations and drawing. *Four hours.* Professor DENISON, Mr. WRENTMORE, and Mr GOULDING.

    Course 5 must be preceded by Course 1.
6. Shades, Shadows, and Perspective. *Three hours.* Professor DENISON. (Elective.)

    Course 6 must be preceded by Course 5.
7. Free-Hand Drawing (advanced). *Three hours.* Professor DENISON and Miss HUNT. (Elective.)
8. Architectural and Water-Color Drawing. *Two hours.* Professor DENISON and Miss HUNT. (Elective.)

    Course 8 must be preceded by Course 1 or 4.
14. Stereotomy. *Two hours.* Professor DENISON.

    Course 14 must be preceded by Course 5.
16. Free-Hand Lettering. *Two hours.* Mr. WRENTMORE. (Elective.)

    Course 16 must be preceded by Course 1.
17. Spherical Projections. *One hour.* Professor DENISON. (Elective.)

    Course 17 must be preceded by Course 5.

Shop Practice.

All courses in shop practice are under the direction of Professor C. G. TAYLOR, who also gives a few lectures on appliances and materials in each of the Courses *1a*, *2a*, *3a*, and *4a*. These courses may also be continued by advanced students as Courses *1b*, *2b*, *3b*, *4b*.

Special arrangements are made for students who desire to take more advanced work in the shop courses with a view to preparing themselves for teaching these subjects.

EITHER FIRST OR SECOND SEMESTER.

1a. Wood Work and Pattern Work. *Two hours.* Mr. PURFIELD. Fee $5.

1b. Pattern Work, advanced. *Two hours.* Mr. PURFIELD. Fee, $5.

2a. Forging. *Two hours.* Mr. McDONALD. Fee, $5.

3a. Foundry Work. *Two hours.* Mr. WINSLOW. Fee, $5.

4a. Iron Work. *Three hours.* Mr. SMOOTS. Fee, $5.

4b. Iron Work, advanced. *Two hours.* Mr. SMOOTS. Fee, $5.

Surveying.

FIRST SEMESTER.

1. Lectures and Field Practice with Instruments. *Four hours.* Professor J. B. DAVIS.

The field practice in Course 1 continues during favorable weather until Christmas.

4. Use of Instruments. *One hour.* Professor J. B. DAVIS.

6. Continuation of Course 5. Photo-topography. Field work and drawing. *One hour.* Professor J. B. DAVIS.

The ability to make photographic negatives will be of service.

SECOND SEMESTER.

2. Continuation of Course 1. Lectures and text-book. *Five hours.* Professor J. B. DAVIS.

Course 2 must be preceded by Course 1.

4. Field Work in Camp for Four Weeks. Professor J. B. DAVIS.

Course 3 must be preceded by Courses 1 and 2. Except by special permission it is open only to students who are working for a degree in civil engineering.

5. Topography. Transit and Stadia. Plane Table. Field work and drawing. *Three hours.* Professor J. B. DAVIS.

Course 5 is given four times a week for thirteen weeks.

7. Geodesy. Geodetic Methods. Lectures and text-book. *Three hours.* Professor J. B. DAVIS. (Elective.)

Course 7 must be preceded by Courses 1 and 2. It is given five times a week for twelve weeks.

Civil Engineering.

FIRST SEMESTER.

1. Municipal Engineering. Lectures and text-book. *Five hours.* Professor J. B. DAVIS. (Elective.)
4. Graphical Analysis of Structures. *Two hours.* Professor GREENE.
   Course 4 must be preceded by Course 3.
5. Strength and Resistance of Materials. *Two hours.* Professor GREENE.
   Course 5 must be preceded by Course 4 in mathematics. In 1900-1, Course 5 will be given in the second semester only.
6. Engineering. Theory of Construction. *Two hours.* Professor GREENE.
   Course 6 must be preceded by Course 4 in mathematics.
7. Engineering Design. *Five hours.* Professor GREENE.
   Course 7 accompanies Course 6.
9. Hydraulics. *One hour.* Professor GREENE.
   Course 9 must be preceded by Course 6 in mathematics.

PRIMARILY FOR GRADUATES.

11. Engineering Design, advanced. *Five hours.* Professor GREENE.

SECOND SEMESTER.

2. Tests of Materials. *One hour.* Professor GREENE. (Elective.)
3. Graphical Analysis of Structures. Two sections. *Two hours.* Professor GREENE.
   Course 3 requires at least a limited knowledge of statics.
5. Strength and Resistance of Materials. Two sections. *Two hours.* Professor GREENE.
   Course 5 must be preceded by Course 4 in mathematics.
8. Engineering. Theory of Construction. *Three hours.* Professor GREENE.
10. Water Supply and Sewerage. *One hour.* Professor GREENE. (Elective.)

PRIMARILY FOR GRADUATES.

12. Water Supply and Sewerage. *Two hours.* Professor GREENE.
13. Economics of Railway Location. *One hour.* Professor GREENE.
14. Contracts and Specifications. *One hour.* Professor J. B. DAVIS.

Mechanical Engineering.

FIRST SEMESTER.

2. Elements of Mechanism. *Two hours.* Professor DENISON.
   Course 2 must be preceded by Course 1 in mathematics, and by Courses 1 and 5 in drawing.

3. Dynamics of Machinery. *One hour.* Mr. GRIMES.
Course 3 must be preceded by Course 4 in mathematics, and by Course 1 in physics.

4. Boilers. Steam Engines. *Two hours.* Mr. ALLEN.
Course 4 must be preceded or accompanied by Course 3.

8. Theory of Machine Design. *Three hours.* Professor COOLEY.
Course 8 must be preceded or accompanied by Course 5 in civil engineering.

15. Prime Movers. Water-wheels and Steam Engines. *Two hours.* Professor COOLEY and Mr. ALLEN.
Course 15 must be preceded by Course 3.

PRIMARILY FOR GRADUATES.

16. Heating and Ventilation. *Two hours.* Mr. ALLEN.
Course 16 must be preceded by Course 4.

18. Hydraulic Machinery. *Two hours.* Professor COOLEY.
Course 18 must be preceded by Course 7 or 15.

19. Gas Engines. *Two hours.* Professor COOLEY.
Course 19 must be preceded by Course 13.

20. Laboratory Work. Advanced Course. *Two hours.* Mr. STEVENS.
Course 20 must be preceded by Courses 9 and 11.

EITHER FIRST OR SECOND SEMESTER.

6. Machine Design. Machine Tools. *Two hours.* Professor C. G. TAYLOR.
Course 6 must be preceded or accompanied by Course 2, and be preceded by Courses 1, 4, 5 in drawing.

9. Laboratory Work. Power Measurements. Machine Testing. *Two hours.* Professor COOLEY, Mr. ALLEN, and Mr. STEVENS. Fee, $5.
Course 9 must be preceded by Course 3.

10. Machine Design. Hoisting Machinery. *Three hours.* Professor COOLEY and Mr. GRIMES.
Course 10 must be preceded or accompanied by Course 8.

11. Laboratory Work. Steam Engineering. *Three hours.* Professor COOLEY, Mr. ALLEN, and Mr. STEVENS. Fee, $5.
Course 11 must be preceded or accompanied by Course 4, 7, or 15.

12. Machine Design. Engines and Boilers. *Two hours.* Professor COOLEY and Mr. GRIMES.
Course 12 must be preceded or accompanied by Course 8.

SECOND SEMESTER.

1. Elements of Machines. Nomenclature. *Two hours.* Mr. STEVENS.

5. Mechanism: Valve Gears. *Three hours.* Professor DENISON.
Course 5 must be preceded by Course 2.

7. Hydraulic Machinery. *One hour.* Professor COOLEY.
   Course 7 is intended for those who have taken Course 4. It must be preceded by Course 3.
13. Steam Engines and other Heat Engines. *Three hours.* Mr. ALLEN.
   Course 13 must be preceded by Course 4.
14. Power Plants. Power Transmission. *Two hours.* Professor COOLEY.
   Course 14 must be preceded by Course 7 or 15.
15. Prime Movers. Water-wheels and Steam Engines. *Two hours.* Professor COOLEY and Mr. ALLEN.
   Not given in 1899–1900. See first semester.

PRIMARILY FOR GRADUATES.

17. Compressed Air. Mechanical Refrigeration. *Two hours.* Professor COOLEY.
   Course 17 must be preceded by Course 13.
21. Specifications and Contracts. *One hour.*
   Course 21 must be preceded or accompanied by Course 14.

Electrical Engineering.

FIRST SEMESTER.

2. Electrical Measurements: Carhart and Patterson's Electrical Measurements. Recitations and laboratory work. *Four hours.* Professor PATTERSON, Dr. GUTHE, and Mr. JONES. Fee, $3.
   Course 2 must be preceded by Courses 1, 2, 3 in physics; a knowledge of calculus is required.
5. Alternate Current Apparatus. Recitations and laboratory work. *Three hours.* Professor PATTERSON and Mr. JONES. Fee, $1.
   Course 5 must be preceded by Course 4.
6. Photometry of Electric Lamps; Palaz's Photometry. Recitations and laboratory work. *One hour.* Mr. JONES. Fee, $1.
7. Design of Electrical Machinery and Appliances. *Four hours.* Mr. JONES.
   Course 7 must be preceded by Course 4*a* or 4*b*.

SECOND SEMESTER.

1. Primary and Secondary Batteries: Carhart's Primary Batteries. Recitations and laboratory work. *Two hours.* Dr. GUTHE. Fee, $1.
   Course 1 must be preceded by Courses 1, 2, 3 in physics, and by a course in general or in analytical chemistry.
3. Electrical Measurements. Continuation of Course 2. Lectures and laboratory work. *Three hours.* Dr. GUTHE and Dr. TROWBRIDGE. Fee, $2.

4*a*. Dynamo-Electric Machinery. Lectures, recitations, and laboratory work. *Four hours.* Professor PATTERSON and Mr. JONES. Fee, $2.

Course 4*a* must be preceded by Course 2.

4*b*. Dynamo-Electric Machinery, as in Course 4*a*. *Three hours.* Professor PATTERSON and Mr. JONES. Fee, $1.

Course 4*b* must be preceded by Course 3*c* in physics.

8. Distribution of Electricity. Lectures and recitations. *Two hours.* Mr. JONES.

Course 8 must be preceded by Course 4*a*.

10. Advanced Course in Design of Electrical Apparatus. *Two hours.* Mr. JONES.

PRIMARILY FOR GRADUATES.

9. Alternating Current Phenomena: Steinmetz. *Two hours.* Professor PATTERSON.

Course 9 must be preceded by Course 5.

Marine Engineering.

FIRST SEMESTER.

1. Naval Architecture. Professor COOLEY.

SECOND SEMESTER.

2. Marine Engines. *Three hours.* Professor COOLEY. (Elective.)
3. Ship Building. Professor COOLEY.

Course 2 is designed for graduates and for undergraduates who have had the necessary training. Courses 1 and 3 are for graduates. It is proposed to extend these courses much more in the near future.

Mining Engineering.

SECOND SEMESTER.

1. Exploitation of Mines. Methods of opening, laying out, and working mines. *Five hours.* Professor PETTEE. (Elective.)

Course 1 requires a knowledge of mineralogy and general geology.

SEQUENCE OF STUDIES.

The studies of the first and second years are *prescribed*, except so far as credit obtained in advance may leave a place for substitutions, or the presentation of Latin as one of the requirements for admission may make some change necessary. In the third and fourth years some opportunity for elective studies is open. The work for the first year is the same for all students. At the end of the first year, the student makes his choice to continue in the civil engineering, the mechanical engineering, the electrical engineering, or the chemical engineering course.

ORDER OF STUDIES.

First Year.

The same for all regular students.

FIRST SEMESTER.

	EXERCISES PER WEEK
French or German D.*	3
English 1, Paragraph writing.	2
Mathematics 1, Algebra and Analytic Geometry, I.	4
Drawing 1, Elementary Drawing.	2
Drawing 4, Freehand Drawing.	3
Shop Practice 2*a*, Forging (one-half of class); or 1*a*, Woodwork (one-half of class).	2
	16

SECOND SEMESTER.

French or German E.	3
Physics 1, Mechanics, Sound and Light.	5
Mathematics 2, Analytic Geometry, II.	4
Drawing 5, Descriptive Geometry.	4
Shop Practice 1*a*, Woodwork, or 2*a*, Forging.	2
	18

Second Year.

The student will now select his course and report it to the Dean. Studies marked C, M, E, and Ch. are to be taken by civil, mechanical, electrical, and chemical engineering students respectively.

FIRST SEMESTER.

German or French A, Beginners' Course.		3
Physics 2, Heat, Electricity and Magnetism.		5
Mathematics 3, Calculus.	C, M, E	5

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* The student who enters with German will continue that language through the first year and begin French in the second year. The student who enters with French will continue French a year and then begin German. The student who enters with Latin will take French or German A.

s 3*b*, Laboratory Work.	E	2
tical Chemistry 1, Qualitative Analysis.	Ch	10
alogy 1.	C	2
gy 12, Elements.	C	3
Practice 1*b*, Woodwork, advanced.	M	2
Practice 3*a*, Foundry, or 4*a*, Ironwork. ne-half of class.) (One-half of class.)	M, E	2 or 3

C 18; M, E 17 or 18; Ch 18

SECOND SEMESTER.

n or French B.		3
h 1*a*, Theme Writing.		2
matics 4, Calculus and Mechanics, I.	C, M, E	5
s 3*c*, Mechanical and Electrical Measurements.	C, M, Ch	3
al Chemistry 2, Laboratory Work.*	C	3
tical Chemistry 4, Quantitative Analysis.	Ch	7
ng 14, Stereotomy.	C	2
Practice 1*b*, Woodwork, advanced.	E	2
ork Practice 4*a*, Ironwork, or 3*a*, Foundry.	M, E	3 or 2
nical Engineering 1, Elements of Machines.	M	2
ical Engineering 1, Primary and Secondary Batteries.	E	2

C 18; M 18 or 17; E 17 or 16; Ch 15

Third Year.

FIRST SEMESTER.

h or German C.	C, M, E	3
h or German D.	Ch	3
matics 3, Calculus.	Ch	5
matics 6, Calculus and Mechanics, II.	C, M, E	5
al Chemistry 2, Laboratory Work.	M	3
tical Chemistry 10, Organic Chemistry.	Ch	5
tical Chemistry 31, Chemical Technology.	Ch	5
Practice 4*b*, Ironwork, advanced.	M	2
ying 1, Instruction and Practice.	C	4
ying 6, Photo-topography.	C	1
nical Engineering 2, Mechanism, Elements.	C, M, E	2
nical Engineering 3, Dynamics of Machinery.	C, M, E	1
nical Engineering 4, Boilers, Steam Engines.	M	2
nical Engineering 6, Design of Machine Tools.	E	2
ical Engineering 2, Electrical Measurements.	E	4

C 16; M, Ch 18; E, 17

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alytic Chemistry 3, Qualitative Analysis, *five hours,* may be substituted for l Chemistry 2, if the student has advanced credit.

SECOND SEMESTER.

Mathematics 4, Calculus and Mechanics, I.	Ch	5
Analytical Chemistry 5, Quantitative Analysis, advanced.	Ch	5
Analytical Chemistry 11, Organic Preparations.	Ch	2
Analytical Chemistry 32, Organic Technology.	Ch	5
Shop Practice 4*b*, Ironwork, advanced.	E	2
Surveying 2, Advanced Surveying.	C	5
Surveying 3, Field Work in Camp.	C	
Surveying 5, Topography.	C	3
Civil Engineering 3, Graphics,	C, M, E	2
Civil Engineering 5, Resistance of Materials.	C, M, E	2
Mechanical Engineering 5, Mechanism, Valve Gears.	M, E	3
Mechanical Engineering 6, Design of Machine Tools.	M	2
Mechanical Engineering 7, Hydraulic Machinery.	M, E	1
Mechanical Engineering 13, Steam Engines.	M	3
Electrical Engineering 3, Electrical Measurem'ts, advanced	E	3
Electrical Engineering 4*a*, Dynamo-Electric Machinery.	E	4
Electrical Engineering 4*b*, Dynamo-Electric Machinery.	C, M	3

C 15; M 16; E 17; Ch 17

Fourth Year.

FIRST SEMESTER.

Mathematics 6, Calculus and Mechanics, II.	Ch	5
General Chemistry 2, Laboratory Work.	E	3
Astronomy 4,* Time, Latitude and Longitude.	C	3
Metallurgy 1, Fuel, Iron and Steel.	M, Ch	3
Surveying 4, Use of Instruments.	M, Ch	1
Civil Engineering 4, Graphics, advanced.	C	2
Civil Engineering 6, Trusses and Structures.	C	2
Civil Engineering 7, Design of Structures.	C	5
Civil Engineering 9, Hydraulics.	C, M	1
Mechanical Engineering 2, Mechanism.	Ch	2
Mechanical Engineering 3, Dynamics of Machinery.	Ch	1
Mechanical Engineering 4, Boilers, Steam Engines.	E, Ch	2
Mechanical Engineering 8, Theory of Machine Design.	M	3
Mechanical Engineering 10†, Design of Hoisting Machinery.	M	3
Mechanical Engineering 11, Steam Engineering, Laboratory.		
Mechanical Engineering 9, Power Measurements, Laboratory.	M	2
Mechanical Engineering 12†, Design of Boilers and Engines.		

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*One-half of the class will be given instruction in the first semester, the other half in the second semester.

†One-half of the class will take 9 and 10, the other half 11 and 12.

Electrical Engineering 5, Alternate Current Apparatus.	E	3
Electrical Engineering 6, Photometry.	E	1
Electrical Engineering 7, Design of Electrical Machinery and Appliances.	E	4
	C 10 or 13; M 13; E 13; Ch 14	

SECOND SEMESTER.

Analytical Chemistry 35, Special Chemistry.	Ch	5
Astronomy 4*, Time, Latitude and Longitude.	C	3
Civil Engineering 8, Theory of Construction.	C	3
Mechanical Engineering 6, Design of Machine Tools.	Ch	2
Mechanical Engineering 7, Hydraulic Machinery.	Ch	1
Mechanical Engineering 10 or 11. (See 1st Semester.)	M	3
Mechanical Engineering 9 or 12. (See 1st Semester.)	M	2
Mechanical Engineering 14, Power Plants, Transmission.	M	2
Mechanical Engineering 15, Prime Movers.	C	2
Electrical Engineering 4*b*, Dynamos.	Ch	3
Electrical Engineering 8, Distribution of Electricity.	E	2
Thesis.	C 5 or 8; M 7; E 2; Ch 11	

Total exercises prescribed, C 119; M 123; E 117; Ch 127.
Required for graduation, 130 exercises.

REQUIREMENTS FOR GRADUATION.

The Degree of Bachelor of Science.

To earn the degree of Bachelor of Science in civil, mechanical, electrical or chemical engineering, the student must secure *one hundred and thirty Hours of Credit*† in a prescribed course of study, as given below, and must present a satisfactory *thesis*. The diploma given indicates the line of study pursued. A time limit is not fixed; but four years is usually needed for the completion of the 130 hours of work.

Bachelors of Arts, of Philosophy, of Science, and of Letters, of this University, and graduates of any other reputable college, are excused from some portions of the general requirements, and are recommended for the same degree with the regular students upon completing the remaining requirements. This work can be done in two years. The culture imparted by classical or other liberal training will be found to have its uses for one engaged in engineering work, and previous dicipline of the faculties in exact research will enable the professional student to master more easily the requirements of the course. All the time the student can devote to general studies before taking up specialties will be well spent.

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*One-half of the class will be given instruction in the first semester, the other half in the second semester.

† For explanation of the term Hour of Credit see page 30, and for further information in regard to the courses prescribed for graduation, see pages 46 to 48.

A choice between the four courses in engineering need not be made before the end of the first year.

GENERAL REQUIREMENTS.

The *general requirements* are as follows:

In French and German: fifteen hours, viz: Courses A, B, C, in one language, and Courses D, E, in the other.
In English: Courses 1, 1*a*.
In Mathematics: Courses 1, 2, 3, 4, 6.
In Physics: Courses 1, 2.
In Drawing: Courses 1, 4, 5.
In Shop Practice: Courses 1*a*, 2*a*.
In Mechanical Engineering: Courses 2, 3.

SPECIAL REQUIREMENTS.

The *special requirements* in the several courses are as follows:

1. *In Civil Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Civil Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Physics: Course 3*c*.
In General Chemistry: Course 2; or Analytical Chemistry: Course 3.
In Mineralogy: Course 1.
In Geology: Course 12.
In Astronomy: Course 4.
In Drawing: Course 14.
In Surveying: Courses 1, 2, 3, 5, 6.
In Civil Engineering: Courses 3, 4, 5, 6, 7, 8, 9.
In Mechanical Engineering: Course 15.
In Electrical Engineering: Course 4*b*.
In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science and the Arts: an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

2. *In Mechanical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Mechanical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Physics: Course 3*c*.
In General Chemistry: Course 2; or Analytical Chemistry: Course 3
In Metallurgy: Course 1.
In Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.
In Surveying: Course 4.
In Civil Engineering: Courses 3, 5, 9.
In Mechanical Engineering: Courses 1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.
In Electrical Engineering: Course 4*b*.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

3. *In Electrical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Electrical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Physics: Course 3*b*.
In General Chemistry: Course 2; or Analytical Chemistry: Course 3.
In Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.
In Civil Engineering: Courses 3, 5.
In Mechanical Engineering: Courses 4, 5, 6, 7.
In Electrical Engineering: Courses 1, 2, 3, 4*a*, 5, 6, 7, 8.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure *one huudred and thirty Hours of Credit.*

4. *In Chemical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in chemical engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Physics: Course 3*c*.
In Analytical Chemistry: Courses 1, 4, 5, 10, 11, 31, 32, 35.
In Metallurgy: Course 1.
In Surveying: Course 4.
In Mechanical Engineering: Courses, 4, 6, 7.
In Electrical Engineering: Course 4*b*.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: An amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

GRADUATE COURSES.

The Degree of Master of Science.

A candidate for the degree of Master of Science in this Department must have previously received the engineering degree of Bachelor of Science from this University, or, if graduated elsewhere, must satisfy the Faculty that he possesses equivalent attainments.

He must choose a *major* subject, which shall occupy one-half of his time, from the work given in this Department, and two *minor* subjects, each to occupy one-fourth of his time, to be selected from any work open to engineering students; all of the work, however, shall be subject to the approval of the Faculty. Study and residence for not less than one year will be required. Among the courses prescribed on previous pages (31 to 41), the following are arranged primarily for graduates:

In Physics: Courses 7, 10, 16.

In Civil Engineering: Courses 11, 12, 13, 14.

In Mechanical Engineering: Courses 16 to 23, inclusive.

In Electrical Engineering: Course 9.

If a candidate for the degree of Master of Science desires to have his work count towards the degree of Civil Engineer, Mechanical Engineer, or Electrical Engineer, the major subject must be taken in the course in which he took his bachelor's degree, and he must submit a satisfactory thesis before such degree as Engineer will be conferred.

The Degrees of Civil Engineer, Mechanical Engineer, and Electrical Engineer.

The conditions on which the degree of Civil Engineer, as an advanced degree, is conferred are as follows:

The degree of Civil Engineer may be conferred upon Bachelors of Science of this University, who have taken the degree for a course in civil engineering, if they furnish satisfactory evidence that they have pursued further technical studies for at least one year, and, in addition, have been engaged in professional work, in positions of responsibility, for another year. The first of the above requirements may be satisfied by pursuing at the University, under the direction of the Faculty, a prescribed course of study for an amount of time, not necessarily consecutive, equivalent to a college year. If the candidate does not reside at the University, his course of study must be approved in advance by the professor of civil engineering, and he must prepare a satisfactory thesis on some engineering topic, to be presented, together with a detailed account of his professional work, one month at least, before the date of the annual Commencement at which he expects to receive the degree.

The condition on which the degrees of Mechanical Engineer, and Electrical Engineer, as advanced degrees, are conferred upon Bachelors of Science of this University who have taken the degree for a course in mechanical engineering, or electrical engineering, are analogous in character and in amount to those given above for the degree of Civil Engineer.

FEES AND EXPENSES.

Matriculation Fee.—Every student before entering any department of the University is required to pay a matriculation fee. This fee, which, for citizens of Michigan, is ten dollars, and for those who come from any other State or country, twenty-five dollars, is paid but once, and entitles the student to the privileges of permanent membership in the University.

Annual Fee.—In addition to the matriculation fee, every student has to pay an annual fee for incidental expenses. This fee is paid the first year of residence at the University, and every year of residence thereafter. Resident graduates are required to pay the same annual fee as undergraduates. The annual fee in the Department of Engineering is, for Michigan students, thirty-five dollars; for all others, forty-five dollars.*

The Matriculation Fee and the Annual Fee must be paid in advance. No portion of the fees can be refunded, except by order of the Board of Regents, to students who leave the University during the academic year. A by-law of the Board of Regents provides that no student or graduate shall be allowed to enjoy the privileges of the University until he has paid all fees that are due.

Fee for Special Entrance Examinations.—An applicant for admission who desires to take the entrance examination at a time not announced is required to pay to the Treasurer a fee of five dollars before permission to take the examinations can be granted him.

Diploma Fee.—The fee for the diploma given on graduation is ten dollars, and the by-laws of the Board of Regents prescribe that no person shall be recommended for a degree until he has paid all dues, including the fee for diploma.

Laboratory Courses.—The required laboratory courses cost approximately as follows: *Shop Practice.*—In the mechanical and electrical engi-

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*An annual fee of ten dollars is required of all graduates who are granted the privilege of pursuing studies for an advanced degree *in absentia*.

neering courses, *thirty dollars*. *Physical Laboratory.*—A charge of *one dollar* is made for a course requiring one exercise a week during one semester, and at the same rate for the longer courses. *Mechanical Laboratory.*—The charge for each course is *five dollars*. *Chemical Laboratory.*—Students who take laboratory courses in chemistry are required to pay for the materials and apparatus consumed by them. The average cost is about *ten dollars*.

The fee required for any course has to be paid before the work of the course is begun.

The total amount of fees paid to the University during the whole four years' course, for matriculation, incidental expenses, materials used and diploma, is, for Michigan students, from $185 to $210; and for others, from $240 to $265, varying more or less according to the student's actual laboratory expenses.

Other Expenses.—Students obtain board and lodging in private families for from three to five dollars a week. Clubs are also formed in which the cost of board is from one dollar and a half to two dollars and a half a week. Room rent varies from seventy-five cents to two dollars a week for each student. The annual expenses of students, including clothing and incidentals, are, on the average, about three hundred and seventy dollars. The University does not undertake to furnish manual labor to students; yet a few find opportunities in the city for remunerative labor.

There are no dormitories and no commons connected with the University. Students on arriving in Ann Arbor can obtain information in regard to rooms and board by calling at the Steward's office.

Students are temporary residents of the city, and, like all other residents, are amenable to the laws. If guilty of disorder or crime, they are liable to arrest, fine and imprisonment. A rule of the University Senate provides that if a student is arrested, or is convicted by the civil authorities, he shall be cited to appear before the faculty of the department in which he is matriculated, and shall be liable to suspension or expulsion.

Department of Engineering.

REGISTER OF ALUMNI.

The degrees of C.E. and M.E. were conferred as first degrees until 1882. Beginning with 1882, the degrees were changed to B.S., and a second degree was given for advanced study with professional experience. Where no note follows the name, the degree was taken in civil engineering.

This register is confined to recipients of degrees in the engineering courses. Some graduates in other courses, and many nongraduates, who have taken work in this department, have occupied and now hold engineering positions of responsibility.

1860.

FRANK KRAUSE. Locating Engr., Iowa Midland R. R., '70–1. With L. H. Evarts & Co., Maps, '71–4. Asst. City Engr., Cleveland, '76. Locating Engr. N. Y. C. & St. L. R. R., '81–2. City Engr., Galion, O., '80–3. Div. Engr. C. C. C. & St. L. R. R., '85–90. Civil Engr. Cleveland, O.

WM. MINTO. U. S. Surveys, '71–5. Chief Engr. Sierra Flume and Lumber Co., '75–7. Asst. Surveyor S. F. Savings Union. Civil and Mining Engr. and Fruit Grower. Orinda Park, Cal.

1861.

PETER S. GIBSON. M.S., '64. M. Can. Soc. C. E. Govt. Ont. Land Surveyor. Mem. Bd. of Exam. Land Surveyors. Engr. for Townships of York, North Toronto, East Toronto, etc. Dom. Land Surveyor and Civ. Engr. Willowdale, Ont., Canada.

GEO. H. SEYMOUR. B.S., '60. Clerk Aud. Gen. Office '61–2. Private 20th Mich., '62–3. Asst. Engr. U. P. R. R., '64–7. Asst. City Engr. Council Bluffs, '67–8. Asst. Engr. K. P. R. R., '69–'70. Do. M. K. & T. R. R., '70–1. Do. N. P. R. R., '71–3. D. L. & L. M. R. R., '73. Fruit Grower. Grand Haven, Mich.

JOSEPH W. WOOD. M.S., '62. Farmer. Sumner, Wash.

1862.

ELMORE H. WELLS. M.D., (Bellevue) '67. A. M., (Lafayette) '69. Instructor Civ. Eng. U. of M., '64. Asst. Engr. N. I. R. R., '64–5. President M. B. Water Co. Physician. Meshoppen, Pa.

*Orlando B. Wheeler. A.B., '62, A.M., M.S., '65, C.E., '79, M. Am. Soc. C.E. U. S. Asst. Astronomer, Transit of Venus, '74. Do. '82. U. S. Asst. Astronomer Total Solar Eclipse, '78. U. S. Asst. Engr. on Geodetic Triangulation. Died at St. Louis, Mo., June, '96.

1863.

Ira S. Dunning. R. R. Eng., '63-'89. City Engr. Aurora, '89-'92. Civ. Engr. Aurora, Ill.

Geo. A. Marr. M.S., '67. M. Am. Soc. C.E. U. S. Asst. Engr. on Survey of N. & N. W. Lakes, '63-77. Do. Mississippi River Surveys, '78-'88. Do. Missouri River Surveys, '88-'91. U. S. Asst. Engr. and Supt. Portage Lake Ship Canal. Houghton, Mich.

Wm. Mendenhall. U. S. Asst. Engr. Lake Survey, Astron. Corps. Prin. City Acad., Indianapolis, '67. Prof. Eng. Earlham Coll. Mining Engr., Colo. Richmond, Ind.

Wm. B. Morgan. A.M., (Haverford) '56. Prof. Math. and Astr. Earlham Coll., '63-5, '67-8; Inst. Math. and Eng'g, U. of M., '65-6; Teaching, Indianapolis H. S., '72-4. Prof. Math. and Eng'g, Purdue Univ., '75-6. Do. Math. and Astr., Penn Coll., '76-'83. Do. Earlham Coll., '83-'98. Lowell, Kas.

Stillman W. Robinson. D.Sc., '96, O. S. U. M. Am. Soc. C.E. Do. Am. Soc. Mech. E. U. S. Asst. Engr., Lake Survey, '63-6. Asst. Prof. Min. Eng. U. of M., '66-'70. Prof. Mech. Eng., U. of Ills., '70-8. Do. Ohio Univ., '78-95. V. Pres. Grip Mach. Co. Mech. Engr. Wire Grip Fastening Co. Do. McKay Shoe Mach. Co. Columbus, O.

1864.

Chas. F. Bellows. A.M., '67. Prof. of Math., Mich. State Normal, Ypsilanti, '67-'91. Principal Central Mich. Normal, '91-8. Ypsilanti, Mich.

1865.

Wm. Bouton. City Engr. and Vice-Pres. Pitzman Co. of Surveyors and Engrs. St. Louis, Mo.

Wm. Donovan. U. S. Asst. Engr. Lake Survey, '65-6. Asst. Engr. J. L. & S. R. R., '67-'70. Chief Engr. do., '70-5. Res. Engr. Gt. W. R. R. of Can., '75-7. Mangr. Dept. Taxes and Collections J. L. & S. R. R. Mayor of Lansing, '84-86. Prest. State Savings Bank. Lansing, Mich.

Arthur Hill. R. R. Survey, '66. Lumberman. Saginaw, Mich.

David McKenzie. B.S., (Rochester) '60. Loc. Res. and Chief Engr. on R. R.'s in Canada and U. S. Civ. Engr. Evansville, Ind.

ACHILLES W. UNTHANK. R. R. Locating Engr. So. America. Prof. in Emperor's Coll., Japan. Preliminary Survey R. R. in China. Civ. Engr. San Francisco, California.

GEO. Y. WISNER. M. Am Soc. C.E. U. S. Asst. Engr. Lake Survey. Do. Geodetic Work Mississippi River. R. R. Location. Survey Ill. and Mich. Canal. Supt. Const'n 10th and 11th Lighthouse Dists., '65–'88. Res. Engr. Miss. River Jetties, Port Eads, La. Sanitary Engr. Detroit Health Dept. Member U. S. Board of Engrs. on Deep Waterways. Detroit, Mich.

1866.

*ABEL R. FLINT. U. S. Asst. Engr. Lake Survey. Died at Detroit May, '84.

LEWIS FOOTE. U. S. Asst. Engr. Lake Survey, '64–'74. Farmer. Worthington, Minn.

ARCHIBALD JOHNSON. M.S., '72. Rodman, Survey of Public Lands, '66–7. Compassman of do., '68–9. Asst. Engr. on R. R., '70–2, '77–8, '82. U. S. Deputy Surveyor, '73–4. Reservoir Surveys, '75, '80–2, Asst. Engr. on Locks and Dams, Eau Claire, Wis.. and Miss. River, '79. U. S. Asst. Engr., '82 to date. St. Paul, Minn.

HORACE W. LEWIS.

JOHN W. REMINGTON.

*CASSIUS M. C. SNOVER. Engr. C. & N. W. R. R., '66–7. Chief Engr. Midland Pacific R. R., '69. Div. Engr. M. C. R. R., '71–'86. Died at Detroit, Feb., '86.

ARTHUR P. WOOD. Asst. Engr. U. P. R. R., '68–'72. Supt. Const'n Tex. Pacific R. R. Colo. Div., '72–5. Asst. Engr. Omaha & N. W. R. R., '75. Chief Engr. O. N. & B. H. R. R. R. R. Contractor. Omaha, Neb.

1867.

GEO. H. BENZENBERG. M. Am. Soc. C.E. M. Am. W. W. Assoc. U. S. Asst. Engr. Lake Survey, and Locating and Const'n Engr. C. M. & St. P. and M. & N. R. R.'s, '68–'74. Do. M. & N. R. R., '74–'81. Consulting Engr. on Sewerage and Waterworks. Consulting Engr. Cinn. W. W., '97–'9. City Engr. and Pres't B'd Pub. Wks. '82–'99. Milwaukee, Wis.

AMOS E. DOLBEAR., (Mining). A.M., '67. Ph.D., '83. A.B. (Ohio Wes.) '66. A.M., do. '69. Prof. Nat. Sc., Bethany Coll., '68-'74. Prof. Physics and Astr., since '74. Tuft's College, Mass.

LOWELL A. GOODMAN. Horticulturist. Westport, Mo.

LEWIS P. JUDSON. U. S. Asst. Engr. Lake Survey and Canal Work, '67. Asst. Engr. C. R. I. & P. R. R., '68–9. City Engr. Council Bluffs, '70–'82. Civ. Engr. and Surveyor. Council Bluffs, Ia.

WILLIAM R. RISING, (Mining). A.B. (Hamilton) '64. Ph.D., (Heidelberg). Prof. Chemistry, Univ. of California. Berkeley, Cal.

*JAMES STEEL, A.B., (U. S. Naval Academy), '68. Engr. U. S. Navy, '68. Died at sea, Aug. '69.

ALEXANDER THOMPSON. Mining Engr. '67–'70. Asst. Prof. Mech. Eng. Ills. State Univ., '70–1. Asst. Prof. Math. and Civ. Eng. Iowa Univ., '72–3. Prof. Mech. Eng. Iowa Agrl. Coll., '73–84. Vice-Pres't K. C. W. & G. R. R. and Chief Engr. N. Am. Land and Timber Co. Lake Charles, La.

EBENEZER S. WHEELER. M. Am. Soc. C.E. U. S. Asst. Engr. Lake Survey, '67–'82. Do. River and Harbor Impts., '82–9. Do. in charge of St. Mary's Ship Canal, '89–'97. Genl. charge Surveys, Nicaragua Canal, '98–9.

1868.

FRANCIS M. BAIN. Asst. Engr. C. & A. R. R. Transitman Bellaire and S. W. R. R. Ann Arbor, Mich.

EDWARD C. BURNS. M. Am. Soc. C.E. Asst. and Chief Engr. R. R. Location and Const'n. U. S. Asst. Engr. Lime Kiln Crossing. Engr. Sewers and Pavements. Jamestown, N. Y.

*BYRON R. CHAFFEE, (Mining). Died at Marcellus, N. Y., May, '70.

BRUTUS J. CLAY. Manufacturer. Farmer. Richmond, Ky.

JOSEPH B. DAVIS. M. Am. Soc. C.E. Asst. Engr. F. S. & G. R. R. and Loc. Engr. O. & B. R. R., '68–9. Loc. Engr. M. C. R. R., '70–1. Swathmore College, '71–2. Asst. Prof. C. E., U. of M., '72–'91. Prof. Geodesy and Surveying, U. of M., '91 to date. Ann Arbor, Mich.

HENRY R. DURKEE, (Mining). Mgr. Silver Smelting Wks., Stockton, Utah. Mining Engr. in Utah, Nev. and Cal. Mines. Pres't Chicago Asbestos Mining and Mfg. Co. Director Drury Nickel Co. Do. St. L. & E. R. R. and St. L. & C. R. R. Dealer in Pig Iron and Coal. Chicago, Ill.

*TOBERT ENTREKIN, (Mining). Died at Independence, Mo., Oct, '77.

*MILO K. HAVENS. Civ. Engr. Died at St. Louis, Mo., '85.

EDWARD S. JENISON. M.S., '72. Architect of Univ. Hall. Architect. Chicago, Ill.

EDGAR S. JOHNSTON. M.D., '79. Physician. Gibsonburgh, O.

Wm. S. McHarg, (Mining). Engr. of Water Supply and Sewerage of Towns, '69–'79. Do. Buildings, '79–'90. Do. World's Columbian Exposition. Civ. Engr. Chicago, Ill.

Philetus H. Philbrick. M.S., '73. Asst. Engr. J. Ft. W. & C. R. R., '68–9. Chief Engr. Owosso & N. W. R. R., '69–'72. Do. T. A. A. & N. M. R. R. Asst. Engr. Mich. Air Line. Prof. Civ. Eng. Iowa Univ., '73–'87. Chief Engr. K. C. W. & G. R. R. N. Am. Land and Timber Co. Lake Charles (Pineville) La.

Charles Poore. Civ. Engineer. Western Springs, Ill.

Rollin J. Reeves. U. S. Govt. Surveyor, Dak., Wyo., Oregon, Cal., N. Mex., Minn., Idaho, Colo. and Montana, '70–'82. Cashier 1st Nat. Bk. Wilbur, '82–6. Real Estate, '86–'90. Vice-Pres't Columbia Milling Co, '94–5. U. S. Circuit Court Com'r. Wilbur, Washington.

Fillmore M. Smith, (Mining). Mining Engr. and Chemist. Syracuse, N. Y.

Milford N. Wells. Asst. Engr. Ft. W. J. & S. R. R., '68–'70. Do. Mich. Air Line, '70–2. Do. J. L. & S. R. R., '72–4. Chief Engr. T. A. A. & N. M. R. R., '78–'80. Asst. and Loc. Engr. A. T. & S. F. R. R., '80–2. Min. Engr. do. '82–5. Chief Engr. S. K. R. R., '85–8. Res. Engr. do. '88 to date. Chanute, Kan.

1869.

Hugh B. Alexander. Asst. Engr. San. Dist. Chicago. Geneva, Ill.

Wm. H. Boardman. A.B. '68. Editor and Publisher. Pres't of the *Railroad Gazette* Co. New York, N. Y.

Chas. F. Brush, (Mining). Ph.D. (Western Reserve) '80. (Cross of the Legion of Honor by French Government, 1881). M. Am. Soc. Mech. E., do. Am. Inst. E.E. Anal. Chemist and Expert '69–'73. Electrical Engr. and Inventor. Inventor of Brush Electric Light Apparatus. Scientific Investigator. Cleveland, O.

Orson O. Fox. Merchant. Pleasant Prairie, Wis.

Chas. H. Hamilton, (Mining). Wis. Legislature, '78. Milwaukee Sch. Bd., '89–'91. Do Common Council, '92–4. City Atty., '94. Atty. at Law. Milwaukee, Wis.

James C. Holliday, (Mining). Engr. Milwaukee Iron Mfg. Co., '70–2. Real Estate, Minneapolis. Mining Engr. Chicago, Ill.

***George B. Lake.** Asst. Engr. A. T. & S. F. R. R., '71. Div. Supt. do. '76. Supt. Track and Bridges, do. '78. Chief Engr, do. '84. Died at Topeka, Kan., Apr. 1884.

DANIEL H. RHODES. Div. Engr. on Mich. R. R's., '69–'72. Do. C. & A. R. R. and B. & S. W, R. R. '72–8. Asst. Engr., Res. Engr. and Supt. A. T. & S. F. R. R., '79–'85. Chief Engr. K. P. & W. R. R. and W. & W. R. R., '85–9. Civ. Engr. Wichita, Kas.

ALBERT A. ROBINSON. M.S., '72. M. Am. Soc. C.E. Asst. Engr. St. Joe & D. C. R. R., '69–'71. Do. A. T. & S. F. R. R., '71–5. Chief Engr. do. '75–'88. Supt. N. Mexico Div. '80. Asst. Gen. Supt. and Gen. Supt., '82. Chief Engr. '83. Second Vice-Pres't. and Chief Engr. '89–'93. Pres't Mex. Cen. R. R. Boston, Mass.

*THOMAS J. SEELEY. M. Am. Soc. C.E. Chief Engr. Chicago & Millington R. R., '69–'76. Asst. Engr. A. T. & S. F. R. R., '77–'83. Died in Kansas., Oct. '83.

LUCIAN SWIFT, (Mining). Engr. N. P. R. R., '71–6. Mangr. Minneapolis Journal. Minneapolis, Minn.

ELIJAH TREADWELL. Asst. Engr. F. & P. M. R. R., '70–'81. Res. Engr. A. T. & S. F. R. R., '81–9, Chief Engr. Cin. Sag. & M. R. R., '89–'90. Asst. Engr. F. & P. M. R. R. East Saginaw, Mich.

*JOHN WHITING. U. S. Lake Survey; '69–'70. Died at St. Clair, Mich., Aug. '70.

BENEZETTE WILLIAMS. Asst. City Engr. Chicago, '72–8. City Engr. do. '79. Consulting Engr. Drainage & Water Supply Com'n. '86. Chief Engr. San. Dist. of Chicago, '92. Civ Engr. and Contractor. Chicago, Ill.

1870.

*JUDSON S. BIRD. Engr. and Contractor. Died in Kansas., March '82.

CLARENCE M. BOSS, (Mining.) Geol. Survey Mich., '70–1. Const. Engr. H. & O. R. R., '71–2. Engr. Marquette Co. Mines, '72–6. R. R. Wk. '77–8. Exploring, '79–'80. Div. Engr. C. & N. W. Ry., '81–2. Engr. Gogebic Co. Mines, '86–8. Inspector do. '89–'95. Genl. Mangr. Franklin Mines, '96–7. Asst. Engr. D. M. &. N. Ry., '97 to date. Duluth, Minn.

JOHN L. CULLEY. U. S. Inspector Harbor Impt., '70. Asst. Engr. A. Y. & P. R. R., '71–2. Asst. City Engr. Cleveland, '73–8. Civil Engineer. Cleveland, O.

HARLOW P. DAVOCK. M.S. '73. Asst. Engr. St. L. & S. E. R. R., C. & V. R. R., Erie R. R., Cin. So. R. R., '70–4. U. S. Asst. Engr. St. Mary's Falls Canal, '75–'82. Do. Cascade Locks, '81–'82. Member Legislature, '93–4. Pres. Board of Health, '95 to date. Attorney at Law. Detroit, Mich.

LUTHER E. FERGUSON. U. S. Lake Survey, '74. Farmer. White Pigeon, Mich.

CHAS. P. GILBERT. R. R. Engr. in Mo., Ill. and Ind., '70-1. U. S. Asst. Engr. St. Mary's Falls Canal, '71-4. Do. Sand Beach Harbor of Refuge, '74-'88. Mgr. of Edison Illum. Co., Detroit, '88-'96. Do. Central Station Elec. Lighting and Power Co. Man'g'r. Sacramento Elect. Gas and R. Co., '96-9. Pres. Pac. Coast Elect. Transmission Ass'n., '97-'98. San Francisco, Cal.

***JAMES A. HAYWARD.** U. S. Harbor Survey, '73. U. S. Asst. Engr. Galveston Harbor. Drowned near Texas Coast, Aug. '80.

CHAS. J. KINTNER. U. S. Asst. Engr. and Astronomer, Wheeler Geog. Survey, '77-8. Chf. Clerk U. S. Patent Office, Electrical Div., '82-7. Elect. Expert and Pat. Atty. New York, N. Y.

MICHAEL A. MEYENDORFF. Engr. Big Wabash Bridge. Do. No. Pac. R. R. '72. Deputy U. S. Min. Surveyor, Arizona and Montana, '73-4. Supt. Const'n U. S. Assay Office, Helena, '75. Melter U. S. Assay Office, '76-'88. Lecturer. New York, N. Y.

GEO. W. MICKLE. R. R. Survey in Iowa, '70. U. S. Lake Survey, '70-1. Asst. to Prof. Watson, Preparing Lunar Tables, '71-3. Contractor, '71-77. Mickle & Bird Map Co., Kansas, '77-'81. Dealer in. Agrl. Machinery, '81-'91. Real Estate and Loans. Kansas City, Mo.

ALFRED NOBLE. M. Am. Soc. C.E. U. S. Asst. Engr. St. Marys Falls Canal, '70-'82. Gen. Supt. do., '81-2. Res. Engr. Shreveport Bridge '82-3. Gen. Asst. Engr. N. P. R. R.; '82-6. Res. Engr. Washington Bridge, '86-7. Do. Cairo Bridge, '87-9. Do. Memphis Bridge, '88-'92. Asst. Chief Engr. Bellefontaine, Alton and Leavenworth Bridges, '92-4. Mem. Nicaragua Canal Com'n., '95. Mem. U. S. Board of Eng'rs. on Deep Water Ways, '97-9. Pres. Western Soc. Engrs. Civil Engineer. Chicago, Ill.

HENRY C. RIPLEY. U. S. Asst. Engr. Imp. Great Lakes and Gulf of Mexico, '70-'90. Civ. and Hydrographic Engineer, Private Practice, '90-'99. Galveston, Tex.

WM. J. WATERS, (Mining).

WARREN C. WILLITS. Deputy U. S. Min'l and Land Surveyor. Examining Clerk in U. S. Sur. Gen's. Office for Colo. Denver, Colo.

1871.

ALBERT E. BALDWIN.

ALLEN P. BOYER. Manufacturer. Goshen, Ind.

***JAMES D. BURR.** M. Am. Soc. C.E. Loc. Engr. on A. T. & S. F. R. R., '72-3. Res. Engr. C. & S. R. R., '75-7. Asst. Engr. A. T. & S. F. R. R., '77-'86. Died at Topeka, Kan., May, '86.

JOHN EISENMANN. U. S. Asst. Engr. Lake Survey and Miss. Riv. Com., '71–'82. Prof. Eng. and Drawing, Case Sch. of App. Science, '82–6. Consulting Architect Cleveland Bd. Education. Do. City Hall Com'n. Arch't Ohio Masonic Home, etc. Mem. Ohio State House Commission. Architect and Engineer. Managing estates. Cleveland, O.

JOHN A. FULTON. M. Am. Soc. C.E. Loc. and Const. Engr. Cin. So. R. R., '73–5. Div. Engr. A. T. & S. F. R. R., '76–'80, '82 and '88. Do. A. &. P. R. R., '81. Engr. Smith Bridge Co., '83–5. Asst. Engr. C. S. F. & Cal. R. R., '86–7. Res. Engr. T. St. L. & K. C. R. R., '88. Asst. Engr. A. T. & S. F. R. R. Topeka, Kan.

JOSIAH L. LITTLEFIELD. Co. Surveyor and Civ. Engr., '71–5. Lumberman and Manufacturer. Farwell, Mich.

*LYMAN MASON. B.S., (Mich. Agl.) '69. M.S. do. '71. Asst. Engr. J. L. & S. R. R., '71–2. Died at Gaylord, Mich., July '81.

ADRIAN J. PARSHALL. Chief Clerk State Bd. Land Com'rs. Cheyenne, Wyoming.

*BARON H. PENNINGTON. Surveyor and Farmer. Died at Macon, Mich., Feb. '96.

ELLIOTT D. PERRY. Salt Lake City, Utah.

CHARLES PRATT. A.M. (Madison) '76. M.D. (Jefferson Med. Coll.) '81. U. S. Asst. Engr. Lake Survey, '72–8. Do. St. Mary's Ship Canal, '78–'81. Physician. Fall Brook, Pa.

HENRY G. PROUT. M. Am. Soc. C.E. In Ch'ge Survey Riverside Imp., Cook Co., Ill., '71. Topog. U. S. Expedition, Yellowstone. Engr. P. & Y. R. R. Do. Saddle Riv. R. R., '72. Major of Eng'rs. and Col. of Staff, Egyptian Army. Governor Equatorial Provinces, '74–8. Chief Editor *Railroad Gazette.* New York, N. Y.

ALEXANDER B. RAYMOND. Engr. Chicago & Mich. L. S. R. R., '71. Do. M. C. R. R., '72–3. Do. N. Y. C. R. R., '73–5. Asst. City Engr. Detroit, '76–7. Merchant. Sanitary Engr. Bd. of Health, '97–9. Detroit, Mich.

*CURTIS C. SMITH. Died at Pomeroy, O., Sept. 1872.

SAMUEL W. WALKER. Lumber Merchant. Munich, Mich.

J. BURKITT WEBB. Asst. Prof. Civ. Eng. U. of M., '71. Prof. Civ. Eng. Ill. Univ. '72–8. Prof. Math. and Mechanics, Cornell Univ., '80–5. Prof. Math. and Mech., Stevens Inst. Hoboken, N. J.

1872.

CORNELIUS DONOVAN. Asst. Engr. J. L. & S. R. R., '72–4. U. S. Asst. Engr. Lake Survey, '74–6. Do. in charge of Jetties, Mouth of So. Pass, Miss. River, '75 to date. Port Eads, La.

John H. Flagg. M.D. '74. U. S. Asst. Engr. Harbor Imp. Engr. Colo. Cen. R. R. Engr. for Nat'l Gas Co., Chicago. Do. Alley "L" R. R. Contracting Engineer. Chicago, Ill.

***Joshua L. Gillespie.** Ph.B. '71. M. Am. Soc. C.E. U. S. Asst. Engr. Falls of St. Anthony, Minn., '73–7. Do. Miss. Riv. Imp. Died at Hartford, Conn., Aug. '90.

Otto J. Klotz. Private Practice, '72–8. Field Astr., Dept. of Interior, Canada. Alaska Boundary Survey, '85. Astronomer. Ottawa, Canada.

John A. Mitchell. Chief Engr. F. C. and A. & B. R. Ry's., '74–6. U. S. Asst. Engr. Riv. and Harbor Imp. Civil Engineer and Contractor. Luddington, Mich.

Thomas O. Perry, A.M. Engr. U. S. Wind Eng. and Pump Co. and Eclipse Wind Eng. Co., '76–'83. Airmotor Co., Chicago, '87 to date. Inventor and Mfgr. Chicago, Ill.

Edmund M. Spalding. Engr. R. R.'s in No. Mich., '72–8. U. S. Asst. Engr. River and Harbor Imp., Yellowstone River and Superior and Duluth Harbors, '78–'80. R. R. Loc. and Const. Engr. '80–'90. Civil Engineer. Milwaukee, Wis.

Marvin F. Temple. Leveler J. L. & S. R. R., '72–3. Engr. on Surveys in Mexico, '81. Asst. in Gen. Office of A. T. & S. F. R. R., '82–5. Div. Engr. C. B. & N. R. R., '85–6. Div. Engr. C. S. F. & C. R. R., '86–8. Do. U. P. R. R., '89–'93. Res. Engr. G. C. & S. F. R. R., '93. City Engineer. Temple, Tex.

Matthew Tschirgi, Jr. Co. Surveyor, Dubuque Co., Iowa, '72–8. City Engr. Dubuque, '76–'88. Engr. Dubuque High Bridge Co., '88. Prest. and Mgr. Constr. Co. Contractor. Dubuque, Ia.

Robert S. Woodward. U. S. Asst. Engr. Lake Survey, '71–'82. U. S. Asst. Astronomer Transit of Venus Com., '83–4. Chf. Geog. U. S. Geolog. Survey, '84–'90. U. S. Asst. Engr. Coast and Geodetic Survey, '90–3. Prof. Mechanics, Columbia Coll. New York.

1873.

Frank E. Bliss. LL.B., '79. Civ. Engr., '73–'75. Atty. at Law. Cleveland, O.

John H. Darling. U. S. Asst. Engr. Lake and Miss. Riv. Survey, '73–'82. Do. U. S. Harbor Imp. '83 to date. Principal Asst. Engr. River and Harbor Imp., Lake Superior Dist. Duluth, Minn.

Thomas Emery. Architect and Builder. Saginaw, Mich.

***Edwin J. Ferdon.** Lumber Trade, '77–'81. Died at Detroit, Nov., '81.

Frank W. Guernsey. Co. Surveyor, '73–'81. Co. Supt. Sch. Plymouth Co., Ia., '78–'80. Cashier Nat. Bank, '90–8. Co. Treas., '98–9. Dayton, Wash

William J. Head. Sturgeon Bay and Lake Mich. Ship Canal, '71–2. Secy. and Treas. Ferd. Heim Brewing Co., Kansas City, '72–6. Maltster. Chicago, Ill.

Joseph W. Perkins. Chf. Dftsman. Bldg. Dept. A. T. & S. F. R. R., '87–9, Architect, '89–96. Asst. State Archt. Kan., '92–4. Archt. City of Mexico, '96. Mexico City, Mex.

Clarence M. Stephens. Co. Surveyor. Asst. Supt. Yellowstone Park. Dept U. S. Mineral Surveyor. City Engineer. Mt. Clemens, Mich.

William Voigt, Jr. U. S. Asst. Engr. Lake Survey. City Engr. Detroit. Asst. Engr. A. T. & S. F. R. R., '76–'83. Sec. and Treas. Home Brewing Co. Detroit, Mich.

Josiah W. Willis. U. S. Lake Survey, '71. With Bay City Chronicle, '73. Contractor and Builder, '73–4. Prin. of School, Bay City, '74–5. Prin. of Pub. Sch. 48, Buffalo, '78–99. Buffalo, N. Y.

Charles M. Winchell. U. S. Asst. Engr. Lake Survey, '74–8. Do. Miss. Riv. Com., '78–'85, '88–'95. Do. Surveys of Pass Cavallo and Aransas Pass, Tex., '86–7. Engr. Street Dept. St. Louis, '96: U. S. Asst. Engr. Newport, R. I.

1874.

Horace Barnard. Co. Comr., '87–'90. Dep. Co. Treas., '97–9. Surveyor and Farmer. Aberdeen, S. Dak.

Clarence O. Bean. Asst. Engr. N. P. R. R., '80–3. City Engr. Tacoma, '83. Engr. Tacoma Land Co. Civ. Engr. Tacoma, Wash.

Charles L. Doolittle. Sc.D., '96. Asst. U. S. No. Boundary Survey. Prof. of Math. and Astronomy, Lehigh Univ., '75–'95. Do. Univ. of Penn., '95 to date. Philadelphia, Pa.

James M. Everett. M.D. (Rush Med. Coll.) '77. Physician. De Kalb, Ill.

Horace Holmes. U. S. Lake Survey, '74. U. S. Harbor Imp., '75–6. Asst. Engr. M. C. R. R., '82. Civil Engineer. Detroit, Mich.

Julian S. Hull. Engr. Natl. Bd. Underwriters, '74–5. Asst. Engr. N. P. R. R., '75–7. Do. D. & R. G. R. R., '77–'80. Asst. Chief Engr. Tex. S. F. & No. R. R. '80–2. Div. Engr. Mexican Central R. R., '82–5. Contractor's Engr., '85–9. Chief Engr. Deadwood Black Hills R. R., '87–9. Asst. Chief Engr. Chilian Ry.'s, '89–'90. Div. Engr. U. P. R. R. Engr. Sanitary Dist. Chicago, '93–9. Chicago, Ill.

HENRY B. JACKSON. Asst. Engr. R. R. Loc. and Const., '76. Foreman Billet Mill, Ill. Steel Co. Joliet, Ill.

VICTOR H. LANE. LL.B., '78. U. S. Lake Survey, '72–4. Circuit Judge Lenawee Co. Prof. Dept. of Law, U. of M. Ann Arbor, Mich.

CHARLES M. LUNGREN. Editorial Staff *Baltimore Gazette* and *Pop. Scientific Monthly.* Experimental Engineer. New York, N. Y.

JAMES L. RUMSEY. U. S. Dep. Surveyor Oregon, '76–7. Do. '82–5. Supt. of Const. Oregonian R. R., '78–'82. Civil Engineer. Grand Rapids, Mich.

LEVI L. WHEELER. M. Am. Soc. C.E. Asst. Engr. Lake Survey, '74–'81. Do. Miss. Riv. Com., '81–7. Do. Lake Mich., Ill. and Miss. Canal, in Chge. W. Section and Feeder. . Sterling, Ill.

* **ROBERT E. WILLIAMS.** A.B. (Yale) '71. Water Wks. Dealer in R. R. and Shipping Supplies. Died at Hartford, Ct., '87.

* **ORRIN S. WILSON.** U. S. Asst. Engr. No. Boundary Survey, '73–7. Do. Dept. of Texas, '77–'84. Asst. Engr. N. Y. State Survey, '77–'84, '86–7. Engr. N. Y. State Bd. of Health, '84–6. Bldg. Supt. and Engr. State Hospital, '87–'94. Asst. Engr. Erie Canal Impts., '96–8. Died at Buffalo, Jan. 21, '99.

LEVI D. WINES. U. S. Lake and Mo. River Surveys. Prof. Math. Ann Arbor High School. Ann Arbor, Mich.

1875.

ALBERT L. AREY. U. S. Asst. Engr. Miss. River Imp., '75–6. Loc. Engr. Gt. N. R. R. Div. Engr. C. M. & St. P. R. R., '77–'80. Prof. Physics and Chem. Rochester Free Academy, '85. Prof. Chem. Rochester Mech. Inst., '97. Rochester, N. Y.

LUCIUS BAKER. Asst. Engr. L. M. & B. R. R., '75–6. Teaching, Lafayette, Ind., '76–7. Supt. Schools, Owosso, '77–8. M'f'g, Petoskey, '79–'81. Teaching Math., Berkeley, Cal., '81–2. Asst. Engr. C. P. R. R., '82. Asst. in U. S. Magnetic Observatory, Los Angeles, '83. Surveyor, '83–7. Fruit Grower. Fresno City, Cal.

***CHARLES C. BALDWIN.** U. S. Mineral Surveyor, Leadville, Colo., '75–'86. Died at Leadville, Nov., 1886.

HENRY D. BATES. U. S. Mineral Surveyor, Leadville, Colo. Mngr. of Bates Mining Co. Civil and Mining Engineer. Aspen, Colo.

***BEN BIRDSALL, JR.** Lumbering, John A. McGraw, '75–'92. Supt. Vermilion Lumbering Co., Three Rivers, Can., '92–5. Died at Montreal, P. Q., Oct. '95.

CHARLES L. BUCKINGHAM. LL.B. (Columbian Univ.), '80. Asst. Exam. U. S. Patent Office, '76–80. Counsel W. U. Tel. Co., Thompson Houston, Gen. Electric and other Cos. New York, N. Y.

*CHARLES A. CARNEFIX. Teacher. Died at Rock City, Ill., June, '89.

ROLLA C. CARPENTER. M.S. (Mich. Agr. Coll.), '76. M.M.E. (Cornell Univ.), '88. M. Am. Soc. M. E. Prof. of Math. and C.E. Agr. Coll., '76-90. Prof. Exp. Eng., Cornell Univ., '90-9. Consulting Engineer. Ithaca, N. Y.

LEMAN L. DICKINSON. Fruit Grower. Grand Rapids, Mich.

*J. CLEMENT EATON. U. S. Lake Survey, '76-9. Died at Tecumseh, Mich., Feb. '81.

EMERSON W. GRANT. M. Am. Soc. C.E. Mo. Riv. Imp., '79. Res. Engr. A. T. & S. F. R. R., '80-7. Office Engr. Ft. W. & R. G. R. R. Loc. Engr. C. S. F. & C. R. R. Res. Engr. A. T. & S. F. R. R. E. Las Vegas, New Mex.

JOSEPH W. HOOVER. M. Am. Soc. C.E. Engr. Indianapolis Bdge. Co., '75-7. Engr. of Const. W. I. Bdge. Co., Canton, O., '78-'84. Bridge Engr. and Agent, W. I. B. Co., '84-'99. Kansas City, Mo.

*JOHN H. MORRISON. U. S. Asst. Engr. N. & N. W. Lake Survey. Do. Miss. Riv. Surv. and Imp. Asst. Engr. P. Ft. W. & C. R. R.; C. R. I. & P. R. R.; St. P. M. & M. R. R. Civ. Engr, St. Paul, Minn. Real Estate. Died at Columbus, Ohio, Jan. 7, '97.

MARTIN L. NEWTON. Principal High Sch., LaPorte, Ia., '76-8 and '83-5. Chf. Engr. D. I. & D. Ry., '87-8. Do. W. &. C. F. Rapid Transit Co., '96. City Engr. and Co. Surveyor, '89. Waterloo, Ia.

*GEORGE E. PANTLIND. LL.B., '78. Lumber Dealer, Grand Rapids. Died at Chicago, March, '96.

EDWARD I. PARSONS. Supt. Schools, Huron, O., '76-'80. Mining and Mineral Surv., '80-3. Const. Engr. Pacific Cable Const. Co., '83-'90. Civil Engineer. San Francisco, Cal.

WILLIAM H. POTTER. Asst. Engr., Gen'l. Roadmaster, Engr. M. of W., Penna. Co., '75-'95. Supt. do. '95 to date. Toledo, O.

EDGAR D. ROOT. Asst, to City Engr., Jackson, Mich., '76. Clerk M. C. R. R., and Blue Line. Chicago, Ill.

WALTER S. RUSSEL. M. Am. Soc. M.E. Vice-Pres. and Mgr. Russel Wheel and F'dy Co. V. Pres. Am. Soc. M.E., '98. Detroit, Mich.

MARCUS J. WELLS. Co. Surveyor. City Engr. U, S. Asst. Engr. Riv. Imp. Div. and Loc. Engr. R. R. Woodston, Kan.

1876.

DEWITT C. ALLEN. Surveyor and Farmer. Cattaraugus, N. Y.

James O. Caldwell. Teaching, '77–'84. Prin. Salem Academy, O. '84–6. Prof. of Math. and Astron., Wilmington Coll., O., '82. Prin. Fountain School, Pueblo, Colo., '84. U. S. Dep. Mineral Surveyor. Pueblo, Colo.

Frank P. Davis. M.S. (Mich. Agl. Coll.) '72. M. Am. Soc. C.E. Loc. and Const. Engr. C. M. & M. R. R., '70–4. D'ftsman, Washington, '79–'81. Res. Engr. D. & Rio Grande W. R. R., '81. Loc. Engr. Rocky Mt. Div. Can. Pac. R. R., '82–3. Asst. Engr. Dist. Columbia, '84–8. Asst. and Div. Engr. Nicaragua Ship Canal, '89–'93. Chief Asst. Engr. Nicaragua Canal Com., '95. Engr. R. R. Const. and Sanitary Wks. Costa Rica. Asst. Engr. U. S. Deep Waterways Com.

*Lewis C. Donaldson. U. S. Lake Survey, '72–4. Died at Macon, Ill., April, '77.

*Charles A. Marshall. M. Am. Soc. C.E. Bridge Dept. Edge Moor Iron Co., '76–'80. Const. Engr. Cambria Iron Co., '81–4. Engr. of Tests, C. I. Co., '84–9. Drowned in Johnstown Flood, May, '89.

Joseph Ripley. Surveyor Chippewa Co., '76–7. U. S. Asst. Engr. St. Mary's Falls Canal, '77–9. Do. Hay Lake and 21 ft. Channel Imp. St Mary's River, '79–'99. Do. Survey Birmingham Canal, Ala., '97. General Supt. St. Mary's Falls Canal. Sault Ste. Marie, Mich.

John D. Sanders. Teaching, '76–7. D'ftsman and Asst. Insp. Edge Moor Iron Works, '77–8. Asst. Supt. Mine La Motte Lead Mines and Wks., '78–9. Supt. Do. '79–'97. Asst. Mgr. Solvay Process Co., Detroit, '97 to date. Detroit, Mich.

John M. Schaeberle. Asst. in Observatory, U. of M., '78–'85. Acting Asst. Prof. Astron., '85–6. Instructor do., '86–8. Astronomer Lick Observatory, Cal., '88–'98.

Jonathan C. Shepard. Engr. U. P. R. R., '76–'81. Do. U. S. River Imp. Civil Engineer. Escondido, Cal.

Lester H. Strawn. Attorney at Law. Ottawa, Ill.

Alonzo J. Tullock. M. Am. Soc. C.E. Engr. and Proprietor Mo. Valley Bdge. and Iron Works. Leavenworth, Kan.

1877.

Osmer H. Aikine. First Asst. Engr. Monarch Pass, G. & D. R. R., '79–'86. Div. Engr. B. & Mo. Riv. R. R. in Neb., '87. U. S. Dep. Mineral Surveyor. Asst. Gen. Mgr. Magna Charta Silver Min. & Tunnel Co., '91–3. Min. Engr. Gunnison, Col[illegible]

Holland W. Baker. M. Am. Soc. C.E. U. S. Asst. Engr. Miss. and Mo. River Imp. Civil Engineer. St. Louis, Mo.

William Burton. A.B. (Iowa Coll.) U. S. Dep. Surveyor, Co. Surveyor and Notary Public. Kelsey, El Dorado Co., Cal.

Benjamin A. Richards.

Edward J. Snover. City Savings Bank. Detroit, Mich.

James E. Turtle. U. S. Asst. Engr. Riv. Imp., '77-8. Do. Muscle Shoals Canal, '79-'82. Do. Miss. Riv. Imp., '83-6. Do. Harbor Imp. and Imp. of Rivers in Fla. and Ala. Warrington, Fla.

1878.

***Walter S. Abel,** (Mining.) Assay Office, San Francisco. Died at San Francisco, May, '87.

George F. Allmendinger. Mngr. Delhi Mills. Do. A. A. Fruit and Vinegar Co. Do. A. A. Milling Co. Ann Arbor, Mich.

Clarence O. Arey. M.D. (Univ. of Pa.) In Charge Bacteriological Lab., Gov. Exp. Sta., '93. Architect. Cleveland, Ohio.

James D. Du Shane. U. S. Asst. Engr. Miss. Riv. Imp., Plant No. 3, St. Paul to Des Moines Rapids, '78-'84. Do. Plant 2, '85. Do. St. Paul to Lake Pepin. U. S. Asst. Engr. St. Paul, Minn.

Wm. V. Grove. D.D.S. (Ohio Coll.) '81. Dentist. Buffalo, N. Y.

John K. Hanson. Civil Engineer. Concord, Neb.

John B. Johnson. M. Am. Soc. C.E. Do. Am. Soc. Mech. E. U. S. Asst. Engr. Lake Survey, '78-'80. Do. Miss. Riv. Commission, '80-3. Prof. Civ. Eng., Wash. Univ., '85-'99. Dean Dept. Mech. and Eng. Univ. of Wis. Madison, Wis.

Timotheus Josenhans. Architect. Seattle, Wash.

Henry W. Judd, (Mining.) Cashier Wick Banking and Trust Co. Cleveland, Ohio.

Eugene G. Mann, (Mining.) Druggist and Chemist. Ann Arbor, Mich.

Seymour T. Morse. Farmer. Highland, Mich.

Charles F. Owen. Chief Engr. on Steamboat, '78-'82. Engr. Harrison St. Pumping Sta. Chicago, Ill.

***James Sanderson.** Asst. Engr. T. & A. A. R. R. Died at Bay City, Mich., Sept. '85.

Ossian C. Simonds. Landscape Gardener and Supt. Graceland Cemetery. Chicago, Ill.

FRANK L. SIZER. Engr. D. & R. G. R. R., '81. Chf. Clerk U. S. Surveyor General, Montana, '82–3. Genl Mngr. Empire Mining Co., '86–8. Do. Montana Brick & Tile Co. Chief of office Irrigation Inquiry, Dept. of Agrl., Washington, D. C., '93. Civil and Mining Engineer. Helena, Montana.

HIRAM E. TERRY. Co. Surveyor, '79–'80. Asst. Engr. D. L. & N. R. R., '81. Prin. Sch. Maple Rapids, '81–3. Do. Central Sch. E. Saginaw, '84–9. Asst. City Engr. City Engineer. Saginaw, Mich.

EVERT VANPELT. Engr. Leavenworth & Topeka R. R. Civ. Engr. Yoakum, Tex.

ANDREW J. WENZELL. U.S. Asst. Engr. Harbor of Refuge, Sand Beach, '79. Asst. Engr. F. & P. M. R. R., M. C. R. R. and G. R. & I. R. R. Div. Engr. C. M. & St. P. R. R. Chief Engr. S. F. & H. R. R. Engr. Detroit and Belle Isle Bridge. Chief Engr. L. S. & I. R. R., '92–3. Engr. Union Trust Co. Bldg., Detroit. Chief Engr. D. & M. R. R., '94–5. Asst. Engr. C. & N. W. Ry. Butterfield, Minn.

SIDNEY B. WIGHT, (Mining.) Assayer and Chemist, Wyandotte Silver Works, '78. Do. Detroit and Lake Superior Copper Works, '79–'82. Do. Vulcan Ice Co., Newberry, '82–6. Supt. Land Dept. D. M. & M. R. R. and Peninsular Land Co., '86–'91. Secy. to Prest. M. C. R. R. Asst. Purchasing Agt. M. C. R. R. Detroit, Mich.

1879.

CHARLES S. BEADLE. Div., Res. and Loc. Engr. A. T. & S. F. R. R. Chief Engr. K. C. & E. R. R. Loc. Engr. C. & St. L. Electric R. R. City Engineer. Sault Ste. Marie, Mich.

CHARLES C. BROWN. M. Am. Soc. C.E. U. S. Asst. Engr. Lake Survey, '79–'82. Prof. Civ. Eng. Rose Polytechnic Inst., '83–6. Do. Union Coll., '86–'93. Consulting Engr. N. Y. State Board of Health, '87–'93. City Engr., Indianapolis, '93–5. Consulting Engr. Central Eng. Co. Bloomington, Ill.

CHARLES S. HENNING. Res. and Div. Engr. A. & P. R. R., '80–3. Genl. Rdmstr. do. '83–4. Chief Engr. J. C. K. & O. R. R., '85. Prest. Cherokee Coal Mining Co. Cherokee, Kan.

BRAYTON D. KING, (Mining.)

HORATIO T. MORLEY. Shipbuilder and Vessel Owner. Detroit, Mich.

IRVING K. POND. Architect. Chicago, Ill.

JOHN C. QUINTUS, (Mining.) M. Am. Soc. C.E. U. S. Asst. Engr. River and Harbor Imp., '79 to date. Prin. Asst. U. S. Engr. Buffalo, N. Y.

E. **Fred Wood**, (Mining.) Chemist, Union Iron and Steel Co., Chicago. Do. Pittsburg Bessemer Steel Co. Supt. Bessemer Dept. Carnegie Steel Co. Asst. Supt. Homestead Steel Wks. Munhall, Pa.

1880.

John Ayers, (Mining.) Cashier, Nat. Bk. of W. Ark., '80–2. Hardware Merchant, '83 to date. Ft. Smith, Arkansas.

***Joseph A. Beaumont.** Died at Armordale, Kan., March, '85.

Samuel F. Beaumont, (Mining.) Civil and Mining Engineer. St. Louis, Mo.

Edward S. Davis. U. S. Asst. Engr. Miss. Riv. Surveys, '80–3. Co. Surveyor, Hill Co., Texas, '79–'96. Hillsboro, Tex.

George L. Fisher. Architect. Omaha, Neb.

Cicero D. Hill. Asst. Engr. C. M. & St. P. R. R.. Do. D. & R. G. R. R. Do. Hennepin Canal. Do. Dept. Pub. Wks., Chicago. Civil and Consulting Engineer. Chicago, Ill.

Frank P. Satterlee, (Mining.) Assayer. Medical Student, '99. San Francisco, Cal.

1881.

George A. Brown. Civil Engineer. Bloomington, Ill.

Randolph W. Brown. Merchant. Rochester, (?) Minn.

John W. Dorst. Asst. Engr. D. & R. G. R. R., '81. U. S. Asst. Engr. Miss. Riv. Com., '81–5. Manufacturer. New York, N. Y.

William W. Follett. M. Am. Soc. C.E. Div. Engr. N. O. & N. E. R. R., '81–3. Engr. in Charge Red Riv. Bridge, Shreveport, La., '83–5. Div. and Loc. Engr. A. T. & S. F. R. R., '86–'90. Irrigation Survey and U. S. Geological Survey, '89. Asst. Engr. Artesian and Underflow Investigation, '90–1. Cons. Engr. International (Water) Bndry. Com. U. S. and Mexico, '96–9. El Paso, Tex.

John E. Hathaway. Contractor. Milwaukee, Wis.

David E. Hoover. Engr. Sanitary Dept. Pullman, Ill., '81. Asst. Engr. Mex. Central R. R., '82. Surveyor and Vineyardist. Keuka, N. Y.

George A. Lederle. M. Am. Soc. C.E. Asst. Engr. Bismark Bridge, '81–2. Do. Snake River Bridge, '82–3. Engr. in Charge Keithsburg Bridge, '85. Res. Engr. Omaha Bridge, '86. Do. Willamette Bridge, '87. Do. Snake River Bridge, '88. Civil Engineer and Contractor, Firm of Christie and Lowe. Sabine Pass, Tex.

GEORGE W. LILLY. A.B. (Ohio Wesl.) Asst. Engr. Pullman, Ill., '81. Do. W. & L. E. R. R. Bdge., Toledo, '81. Do. S. C. & P. R. R. Bdge. over Mo. Riv., '82-4. Do. Queen and Crescent Ry. and private practice, '83-5. Legislature N. Dak., '89-'90. Atty. at Law, Ashley, N. Dak., '84-'95. Asst. City Engr. Columbus. Columbus, O.

W. CLAYTON MILLER. Supt. Last Chance Mining Co. Mining Engr. Spokane, Wash,

1882.

MALCOLM W. EDGAR. Dftsman. Mich. Car Co., '82-'93. Asst. Mngr. Union Car Co., '93-7. With Detroit Car Co., '97 to date. Detroit.

MARY HEGELER (Mrs. Paul Carus). La Salle, Ill.

WILLIAM H. MCEWAN, Asst. Engr. D. L. & N. R. R., '82-4. Real Estate and Lumber Dealer. Bay City, Mich.

SAMUEL C. WEISKOPF. M. Am. Soc. C.E. Asst. Engr. C. M. & S. P. R. R., '83-6. Inspecting and Bdge. Engr., Pittsburgh, '86-91. Cons. Engineer, '91 to date. New York, N. Y.

1883.

WILLIAM H. BRENTON. Div. Engr. C. & A. R. R., '84-5. Div. and Res. Engr. C. R. I. & P. R. R., '86-8. Asst. Engr. Col. Midland R. R., '89-'91. Res. and Loc. Engr. C. R. I. & P. R. R., '92. Asst. Chief Engr. do., '94. Roadmaster do., '95-6; Col. Midland R. R. Colorado Springs, Col.

LOOMIS E. CHAPIN. M. Am. Soc. C.E. Asst. City Engr., Toledo, '83-7. Hyd. and San. Engr., Toledo, '87-'91. Consulting Engr. City Engineer. Canton, Ohio.

GEORGE H. CHIPMAN. Asst. Engr. V. S. & P. R. R. Bridge at Shreveport. Co. Surveyor. Childress, Tex.

FRANK M. DUNLAP, (Mechanical). M.E., '85. M. Am. Soc. Mech. E. Dftsman. Iron Bay Mfg. Co., '83-4. Supt. Works, Detroit Gas Light Co., '87-8. Dftsman. F. W. Wheeler Co., Bay City, '89-'90. U. S. Asst. Engr. St. Mary's Falls; Designer Hydr. Mach'y, New Lock, '90-6. Mechanical Engineer. Detroit, Mich.

JOHN W. PAYNE. U. S. Surv. and Miss. Riv. Imp., '83-4. In business '84-'92. Asst. City Engr. '92 to date. Akron, Ohio.

JOB TUTHILL. M. Am. Soc. C.E. Transitman, Pikes Peak R. R. '83-4. Dftsman. Bdges. and Bldgs. C. M. & St. P. R. R., '84. Asst. Engr. D. L. & N. R. R., '84-9. Do. D. L. & N. R. R. and C. & W. M. R. R., '89-'90. Engr. of Bridges and Bldgs. do., '90 to date.

Grand Rapids, Mich.

Isaac O. Walker. Topog. Miss. Riv. Survey, '83–5. Asst. Engr. D. L. & N. R. R., '86. Do. T. St. L. & K. C. R. R., '86–9. Engr. Maint. of Way, P. & M. Div., N. C. & St. L. R. R. Paducah, Ky.

1884.

Henry D. Burnett. Supt. Incandescent Lamp Works, Genl. Elect. Co., Lynn, Mass. Do. Canadian Genl. Elect. Co. Peterborough, Ont.

James L. Callard. Div. Engr. C. & N. W. R. R. Res. Engr. M. St. P. & S. S. M. R. R. U. S. Asst. Engr. St. Mary's Falls Canal. Sault Ste. Marie, Mich.

William G. Clark. Jun. Am. Soc. C.E. Div. Engr. T. St. L. & K. C. R. R. Act. Prof. Civ. Eng. Mo. School of Mines, Rolla, Mo., '86–7. Asst. City Engr., Toledo, '87. City Engineer. Toledo, O.

Robert C. Gemmell. C.E., '94. M. Am. Soc. C.E. Div. Engr. A. T. & S. F. R. R. Bldg. and Water Service Eng. C. S. F. & C. R. R. Hydr. Engr. in Ore., Wash., and Utah, '84–'90. Engr. of Sewers, Montesano, Wash. Do. Irrig. Cos. Do. De La Mar's Mercur. Mines, '90–8. State Engr. Utah, '98–to date. Salt Lake City, Utah.

John C. Streng. Chief Dftsman. Industrial Wks., Bay City, '85–'93. Do. Bucyrus Steam Shovel and Dredge Co. So. Milwaukee, Wis.

1885.

Emil Bauer. Saginaw, Mich.

Edward D. Clary. Engr. United Gas Impt. Co., Phila., '86–9. Mgr. Gas Light Co., St. Albans, Vt., '87–9. Asst. Supt. G. L. Co., Paterson, N. J., '89. Mgr. Burlington G. L. Co., '89 to date. Burlington, Ia.

Alexander E. Kastl. M. Am. Soc. C.E. U. S. Asst. Engr. Miss. Riv. Survey and Imp., '82–4. Do. Grand Riv. Survey, '84. Asst. City Engr., Grand Rapids, '85. Asst. Engr. Chicago Drainage Com., '86–7. Asst. Div. Engr. C. S. F. & C. R. R., '87–8. First Asst. Engr. Pamico Riv. Imp., Tampico, Mex., '90–1. Chf. Engr. Brazos Riv. Channel and Dock Co., '91. U. S. Asst. Engr. Red Riv. Survey. Asst. Engr. San. District, Chicago. Div. Engr. Metropolitan Water Supply. Clinton, Mass.

Charles H. Lane. LL.B. (Natl. Univ.) Dftsman. Mo. Valley Bdge. Wks., '86. Prin. Exam. Patent Office. Washington, D. C.

Egbert T. Loeffler. D.D.S., '88. Dentist. Saginaw, Mich.

George F. Samuel. Asst. City Engr. Lake View, Ill., '85–6. Do. Topeka, Kan., '87. Asst. Engr. Dept. Pub. Wks., Chicago, '88–'95. Civ. Engr. Chicago, Ill.

Frank C. Wagner, (Mechanical). A.M., '84. M. Am. Soc. Mech. E. Installing Lighting Plants for Thomson-Houston Elect. Co., '86–7. In Charge Thomson-Houston Co.'s Wk., Mexico, '88–9. Asst. Prof. of Mech. Engineering, U. of M., '90–6. Assoc. Prof. Steam and Elect. Eng., Rose Polytechnic Inst. '96 to date. Terre Haute, Ind.

1886.

Raymond W. Beach. LL.B., '89. Dftsman. Chicago Forge and Bolt Wks., '86. Do. Kansas City Belt R. R., '87–8. Atty. Chicago, Ill.

William W. Campbell. Prof. Math. Univ. of Colo., '86–8. Inst. in Astr. U. of M., '88–'91. Astronomer, Lick Observatory, '91 to date. Mt. Hamilton, Cal.

Lewis E. Dunham, (Mining). Asst. Chemist, Joliet Steel Co., '86. Chemist, Furnace Co., Midland, Mo., '86–7. Private Practice, '87–9. Chemist Ashland Iron and Steel Co., '89–92. Asst. Mgr. Ashland I. and S. Co. '93–6. Mgr. Do. '97. Ashland, Wis.

Fred G. Frink. Asst. Engr. C. & A. R. R., '87. Do. C. & N. W. R. R., '88. Dftsman. Vierling, McDowell & Co. Iron Works. Supt. Cons. Snead & Co. Iron Wks., '89. Instr. Arch. Drawing, Man. Train. Sch. Prin. Drawing Dept., Athenæum, Chicago. Prof. C. E., Univ. of Idaho, '97 to date. Moscow, Idaho.

Leslie W. Goddard. Assoc. M. Am. Soc. C.E. Dftsman. F. C. Rossiter, Chicago. '86–7. Asst. Engr. L. N. A. & C. Ry., '87. Survey. and Eng., San Diego, Cal., '87–9. U. S. Asst. Engr. River and Harbor Imp. Grand Rapids, Mich.

Howard G. Hetzler. Div. Eng. C. B. & Q. R. R. Road Master C. B. & Q. R. R. Chicago, Ill.

Louis C. Hill, (Civil). (Electrical), '90. Engr. D. R. W. & So. R. R., '87–8. U. S. Asst. Engr., '88. Div. Engr., Gt. No. R. R., '89. Prof. Elect. Eng. Colo. Sch. of Mines, '90 to date. Golden, Colo.

William C. King, (Civil). Construction, I. C. R. R., '87–8. Div. Engr. C. B. & A. R. R., '89–'90. Asst. in City Engr.'s Office, Detroit, '96 to date. Detroit, Mich.

Burt McDonald, (Mining). Architect N. Tex. Insane Asylum. Do. State Deaf and Dumb Inst. Do. Chem. Lab. amd Hall, Tex. Univ. Do. Pub. Sch. Lamparac and Austin, Tex. Architect. Austin, Tex.

Fred Morley, (Civil). C.E., '90. M. Am. Soc. C.E. Asst. Engr. A. T. & S. F. R. R., '86–8. U. S. Asst. Engr. Miss. River Imp., '88–9. Instr. C. E. U. of M., '89–94. U. S. Asst. Engr. Grand Riv. Imp., '91. Do. Lake Survey, '93. Prof. C. E., Purdue Univ., '94 to date. Lafayette, Ind.

GEORGE R. SIMPSON, (Civil). M. Am. Soc. Mech. E. Asst. Engr. Lake View, Ill., '85. Asst. Engr. Chicago Forge and Bolt Co., '86. Asst. Exam. Mech. Eng. Pat. Office, '86–9. First Asst. Exam. Metal Working Div., '89–94. Principal Exam. Railway and Rolling Stock Div. Washington, D. C.

CLIFFORD C. SMITH, (Mechanical). Dftsman. Blake Pump Co., '86–7. Chf. Dftsman. for S. T. Wellman. Constn. Engr. Wellman Iron & Steel Co., Chester, Pa. Asst. Head Dftsman. Plate Mill Constn., Ill. Steel Co. Chf. Dftsman. Loco. Crane Dept., Brown Hoisting and Conveying Mch. Co. Cleveland, O.

ERNEST STENGER, (Civil). Assoc. M. Am. Soc. C.E. Dftsman. A. S. F. & C. R. R. Do. Union Ry., Kansas City. Asst. Engr. Mo. Pac. R. R. Asst. City Engr. Omaha, Neb.

1887.

FRANCIS J. BAKER, (Mechanical). Secy. Hammond Light and Power Co. West. Agt. United Elect. Traction Co. Mgr. Madison Light and Power Co. Do. Chicago Illum. Co. Chicago, Ill.

BENJAMIN B. BOWEN, (Civil). Engr. P. and V. Iron Wks., Omaha. Dftsman. Gillette-Herzog Mfg. Co. Minneapolis, Minn.

SEWARD CRAMER, (Civil). Asst. Engr. L. S. & M. S. R. R., '87. Do. Spring Valley Coal Co., '88. City Editor, Washtenaw Times. Ann Arbor, Mich.

CHARLES Y. DIXON, (Civil). Transitman T. St. L. & K. C. R. R., '89. Do. Max Meadows, Va. Land and Impr. Co., '90–1. U. S. Asst. Engr. St. Mary's Falls Canal, '92–6. Do Detroit Riv. Impr., '96 to date. Detroit, Mich.

JOSEPH HALSTED, (Mechanical). Manf. Structural and Ornamental Iron Work. Chicago, Ill.

*WILLIAM R. HAND, (Civil). With Vierling, McDowell & Co. Dftsman, P. E. Lane, Chicago. West. Agt. Lane Bdge. and I. Wks., Denver. Prof. of Eng., Sch. of Mines, Colo. Died at Denver, Oct., '95.

KENDAL W. HESS, (Mechanical). Dftsman. Bay City Indust. Wks., '87–9. Genl. Mgr. McArdle & Sinclair Mfg. Co. New Orleans, La.

JOHN D. HIBBARD, (Mechanical). M. Am. Soc. Mech. E. Vice-Prest. The John Davis Co. Chicago, Ill.

GEORGE B. HODGE, (Civil). Supt. Schools, Le Sueur, Minn., '87–9. Prin. Normal Dept., Univ. of N. Dak., '90–2. Secy. Educ. Dept. International Com. Y. M. C. A., '92 to date. New York, N. Y.

JOHN M. JAYCOX, (Mining). Mech. and Min. Engr. Germantown, Pa.

George Loughnane, (Civil). Asst. Engr. E. J. & E. R. R. Do. Houston, Tex. Cen. & No. R. R. Do. C. & O. R. R. Do. W. & M. R. R. Engr. Peshtigo Co. Marinette, Wis.

John C. Moses, (Civil). B.S. (Urbana), '85. Jun. Am. Soc. C.E. Instr. Math. Urbana Univ., '87-9. Asst. in Bridge Engrs. Office M. C. R. R., '89-'90. Dftsman. Detroit Bdge. Wks., '91-2. Do. Boston Bdge. Wks., '93. Chief Dftsman. do. Asst. Engr. do. Boston, Mass.

***Fred B. Pelham**, (Civil). Asst. Engr. M. C. R. R. Died at Detroit, Feb., '95.

George Roehm, (Civil). Bdge. Insp. M. C. R. R., '87-'90. Chief Dftsman. Milwaukee Bdge. & Iron Co., '90. Do. Wis. Bdge. Co., '92-3. Dftsman. Detroit Bdge. Wks., '91-2. Do. '93 to date. Detroit, Mich.

Benno Rohnert, (Civil). Jun. Am. Soc. C.E. Asst. Engr. Chesapeake Dry Dock Co., Newport News, Va., '88. U. S. Asst. Engr. St. Mary's Falls Canal. Do. Hay Lake and 21 ft. Channel Imp., '97 to date. Sault Ste. Marie, Mich.

James A. Sinclair, (Mechanical). Dftsman. for M. Garland, Bay City. Salesman, E. P. Allis Co., Milwaukee. Prest. McArdle & Sinclair Mfg. Co. New Orleans, La.

Earl P. Wetmore, (Mechanical). Const. Engr. Sprague Elec. Motor Co. Do. N. W. Gen. Elect. Co. Gen. Agt. and Const. Engr. Gen. Elec. Co. Inventor Elec. Water Heaters. Asst. Chief Engr. London United Tramways. Chiswick, London W., Eng.

1888.

Albert Burnstine, (Civil). Inspector, St. Mary's Falls Canal Imp. Supt. and Engr. for Contractors, Sault Locks, '88-9, '90-4. Asst. Engr. Coal Dept. U. P. R. R., '85. Supt. Electrical Zinc Co., N. Y. Contracting Engr. Berlin Iron Bridge Co., '94 to date. Lieut. (Junior Grade) U. S. N., Exec. Off. U. S. S. Apache, '98. East Berlin, Conn.

Fred C. Davis, (Civil). B.S. (Mich. Agl.), '89. Civil Engr. Lincoln, Placeo Co., Cal.

Edwin H. Ehrman, (Mechanical). Dftsman. Morison & Corthell, '88. Do. Chicago Screw Co., '88-'95. Secy. and Supt. Walker & Ehrman Co. Manfr. Bicycles and Parts, '95. Oak Park, Ill.

John E. Hodge, (Civil). M. C. R. R. Gen. Agt. N. E. Mut. Life Ins. Co. Minneapolis, Minn.

JAMES A. LEWIS, (Civil). C.E., '93. Dftsman. and Supt. Arch. Iron Wks., '89–'93. Engr. for C. E. Clark, '93 to date. Chicago, Ill.

ROSS L'H. MAHON, Ph.B., '86, (Mechanical). Dftsman. Dry Dock Eng. Wks., Detroit. Supt. Marinette Iron Wks., Duluth. Investment Broker. Agt. Fidelity & Deposit Co. of Md. Duluth, Minn.

WILLIAM H. MUIR, (Mechanical). Vice-Pres't Eureka Iron and Steel Wks. Secy. and Treas. Jenks & Muir Mfg. Co. Detroit, Mich.

WILLIAM H. PEASE, (Civil). Instr. Math., Chicago, '88–9. Dftsman. Toledo Bdge. Co., '90. Do. Detroit Bdge. Wks. Detroit, Mich.

WALTER R. PARKER, (Mechanical). M.D., (U. of Penn.) '91. Physician. Ensign U. S. N., '98. Detroit, Mich.

WILLARD POPE, (Civil). Asst. Engr. Detroit Bdge. Wks. Detroit, Mich.

PERCY H. RICHARDSON, (Civil). C.E., '91. C. and Min. Engr. Norfolk Coal and Coke Co. U. S. Insp. Riv. and Harbor Imp., N. H. Civil Engineer. Portland, Me.

CHARLES E. ROEHL, (Mechanical). Asst. Dist. Engr. Edison Gen. Elec. Co., '92. Supt. W. & V. Tramway Co., B.-C., '93. Supt. St. Jo. Ry. Light, Heat and Power Co. St. Joseph, Mo.

JOSEPH P. RUSCHE, (Civil). Insp., Morison & Corthell. Asst. to Div. Engr. C. & W. M. R. R. Dftsman. do. Asst. Engr. G. R. & I. R. R. Engr. Records and M. W. and S. Accts. do. Grand Rapids, Mich.

*EDGAR RYAN, (Civil). Dftsman. Anaconda Smelting Wks. Died at Grand Island, Neb., June, '92.

RALPH M. SHANKLAND, (Mechanical). M. Am. Soc. C.E. Asst. Engr. D. H. Burnham & Co. Consulting Engr. Chicago, Ill.

JOHN W. SHOTWELL, (Civil).

ERNEST M. SPRAGUE, (Civil). Asst. Engr. C. & N. W. R. R., '88–'95. Dftsman. Det. Bdge. Wks., '95. Do. Amer. Bdge. Wks., '95–7. Do. N. P. Ry., Bdge. Dept., St. Paul, '97. Engr. S. W. Bdge. Wks., Fort Worth, '97. Engr. and Agt. Gillette-Herzog Co. Denver, Colo.

HERBERT J. STULL, (Mining). Atty. at Law. Rochester, N. Y.

EBENEZER F. WALBRIDGE, (Civil). Engr. Corps, L. S. & M. S. R. R., '89–'90. Do. Toledo, '90–1. Dftsman Massillon Bdge. Co. Agt. Decorative Art Co. Cinn., '92–3. Secy. and Treas. Lloyd Lumber Co. '93–8. Do. Walbridge Lumber Co., '98 to date. Toledo, O.

HENRY E. WHITAKER, (Civil). Jun. Am. Soc. Mech. E. Dftsman. Jesse M. Smith, '88–'94. Machine Designer, F. S. Hubel, '94 to date. Detroit, Mich.

Harry J. Williams, (Mechanical). Mine Supt., '88–'91. Assoc. Manager, '91–5. Beaver Asbestos Co., Hartford Mines. Montreal Asbestos Co. Danville Slate Co. Mangr. Asbestos Mine and Slate Quarry, '95–9. Danville, P. Q., Canada.

1889.

Flavius M. Crocker, (Civil). D'ftsman C. & O. Railway, '89–'90, Engr. and Archt. Supt. Cinn., '90–1. Ass't. Engr. Jenney and Mundie, Archts., '92–3. Architect, '93–4. Asst. Engr. Schreiber & Sons Co., Iron Wks., '94–7. Chief Engr., do. '97. Cincinnati, O.

Herbert S. Crocker, (Civil). Bridge Engr. C. M. & St. P. R. R., '89–90. Asst. to Engr. Bdges. N. P. R. R, '91–4; Asst. Engr. Schreiber & Son's Co., '95. Engr. Bdges. T. H. & B. R. R. '95–6. Do. Lassig Bdge. Wks., '96. Asst. Engr. Bd. Public Wks., '97 to date. Denver, Col.

Julius W. Hegeler, (Civil). Chief Engr. Matthiesson & Hegeler Zinc Co. La Salle, Ill.

William J. Hussey, (Civil). Asst. Naut. Almanac. Instr. Math. and Astron., U. of M., '90–3. Prof. Astron. Leland Stanford Jr. Univ., '94–6. Astron. Lick Observatory, '96 to date. Mt. Hamilton, Cal.

Richard Khuen, Jr., (Civil). Assoc. M. Am. Soc. C.E. Engr. Const. Water Wks., Bismark. Asst. Engr. C. M. & N. R. R. Do. Merchants' Bdge., St. Louis, '89–'90. Shop Insp. Athens, Pa., for Memphis Bdge., '90–1. Asst. Engr. N. Y. L. E. & W. R. R., '91–2. Do. Elevated R. R.'s. in Phila. Asst. Engr. Bridge Dep't. Pencoyd Iron Wks., '92 to date. Philadelphia, Pa.

William A. Livingstone, (Mechanical). Marine Engr. and Agent. Manufacturer. Detroit, Mich.

Frederick H. Loveridge, (Mechanical). Elec. Engr. Standard Elec. Co. Do. Western Elec. Co. Chicago, Ill.

Eugene L. McAllaster, (Mechanical). Asst. Engr. Detroit Dry Dock Co., '89–'94. Mech. Engr. and Naval Archt., '94–9. Seattle, Wash.

William V. Moses, (Mechanical). Dftsman S. T. Wellman, Cleveland, '89. Do. Iron and Steel Co., Thurlow, Pa., '90–3. Instr. Drawing and Mach. Design, Harvard Univ., '93 to date. Cambridge, Mass.

Ernest B. Perry, (Mechanical). M.E. '96. Supt. Industrial Wks. Bay City, Mich.

*William P. Rounds, (Civil). Chief Engr. Cia McHardy, Machinery Mfrs. Campinas, Brazil. Died at Austin, Ill., Nov., '97.

Homer M. Sackett, (Mining). Mining Engr. Aspen (?), Colo.

LOUIS H. SHOEMAKER, (Civil). C.E., '97. D'ftsman J. D. Cook, Toledo. Transitman T. St. L. & K. C. R. R., '89. Asst. Engr. Findlay, O., '90. Do. P. Ft. W. & W. R. R., '91–2. D'ftsman and Asst. Engr. Passaic Rolling Mill Co. Paterson, N. J.

FRANK C. SMITH, (Mining). E.M. '90. Min. and Met. Engr. of various Mines, '92–6. Prof. Geol., Mining and Met., State Sch. Mines, S. Dak., '96–8. Gen. Supt. Golden Reward Geol., M. & M. Co., Deadwood. Vice Pres. and Gen. Mgr. Sunset Min. and Reduction Co. Deadwood, S. D.

DAVID W. SPENCE, C.E. B.S., (U. of Tex.). Dftsman. Lane Bdge. Wks., Denver, '90–1. Do. So. Halsted St. Iron Wks., Chicago, '92. Asst. Prof. '92–8, and Assoc. Prof. C.E., Agl. and Mech. Coll. Tex., '98 to date. College Station, Tex.

GORDON E. STANNARD, (Mechanical). D'ftsman and Salesman, M. Garland, Bay City. Do. Filer & Stowell Co., Milwaukee.

OTHO S. STULL, (Mining). Atty. at Law. West Rush, N. Y.

MINER C. TAFT, (Civil). A.M. (Kalamazoo), '89. Asst. Engr., Kalamazoo, '86–'90 and '91–2. Asst. Engr. Sewers, Dayton and Findlay, O., '90. Leveler Hennepin Canal, '90–1. City Engr., '92–8. Civil Engr. Kalamazoo, Mich.

PHILIP R. WHITMAN, (Mining). Mining, Bacarac, Mex., '90. Engr. Crescent Steel Works, '91–4. Pittsburgh, Pa.

GARDNER S. WILLIAMS, (Civil). Assoc. M. Am. Soc. C.E. Asst. Engr. W. Wks. Bismark, '87. Do. Greenville, Mich., '88. Const. Engr. W. Wks. Owosso, '89. D'ftsman and Supt. Erection, Russel Wheel and Fdry. Co., '90–2. Engr. to Detroit Water Bd., '93–8. Prof. Experimental Hydraulics, Cornell Univ., '98 to date. Ithaca, N. Y.

1890.

FRANK ANDERSON, (Civil). Civil and Mining Engr. Salt Lake City.

FRANK S. BAILLIE, (Civil). Asst. Engr. Gillette Herzog Co., Minneapolis. V. P. and Gen. Mgr. Columbia Gold Min. Co. Sumpter, Ore.

WALTER J. BALDWIN, (Mining). E.M., '94. Asst. Engr. N. Mich. Geol. Survey. Asst. Prof. Mining, Mich. Min. Sch. Prof. Mining Ill. Univ. Asst. Engr. Pa. Traction Co. Romansville, Pa.

WILLIAM D. BALL, (Electrical). E.E., '95. Assoc. M. Am. Inst. E.E. Cons. Engr. Sperry Elec. Min. Mach. Co. and T.-H. Elec. Co., '91–2. Supt. L. K. Comstock Co., '92–4. Designer of Electric Light Plants, '94–5. Engr., Nagle & Ball. Chicago, Ill.

ANDREW R. BENSON, (Civil). Asst. Engr. Clinton and Ill. Bdge. Co., '90–2. Asst. Engr. Sanitary Dist. Chicago, '92–4. Asst, Exam. U. S. Pat. Office, '94 to date. Washington, D. C.

ERNEST B. CONRAD, (Mechanical). Campbell Print. Press & Mfg. Co., '90. Chf. D'ftsman Davidson Pump Co., '91. Catalogue Work Gen. Elec. Co. Lynn, '92-3. Chf. D'ftsman P. Pryibil Co., '94-5. Estim. Engr. Sprague Elec. Co., '96 to date. New York, N. Y.

HENRY W. DOUGLAS, (Mechanical). Mgr. Ann Arbor and Mt. Clemens Gas Cos. Ann Arbor, Mich.

CHARLES A. FISHER, (Civil). D'ftsman with Fisher & Lawrie. Do. Paxton & Vierling Foundry, Omaha. Do. Malcomson & Higginbotham, Arch., Detroit. Insp. Sewers, Pontiac. Fisher Bros., Arch. and Engrs. Pontiac, Mich.

JOSEPH K FREITAG, (Civil). C.E., '94. D'ftsman, Morison & Corthell, '85-8. Asst. Engr. Columbian Expo., '90-1. Asst. to Gen. Supt. do. . Asst. Engr. Metr. Elev. R. R., Chicago, '93-5. Chf. D'ftsman and Engr. Brown-Ketcham Iron Wks. Indianapolis, '95-6. Agt. do., '96-7. Engr. N. E. Office Pencoyd Iron Wks. and Hecla Iron Wks. Boston, Mass,

*WINTHROP E. GASTMAN, (Electrical). Died Pueblo, Col., June, 1893.

WILLIS B. HAYES, (Civil). Thomas & Hayes, Cont. and Con. Engrs. Chicago, Ill.

JOHE R. KEMPF, (Mechanical). D'ftsman Detroit Elec. Wks., '90-1. Insp. Carnegie Steel Co., '91-3. Foreman Insp. Dept. Nat. Cash Reg. Co., '94 to date. Dayton, O.

ROLLO G. MANNING, (Civil). D'ftsman Am. Bdge. Wks., '91-3. Do. Edge Moor Bdge. Co., '93. Chf. D'ftsman Toledo Bdge. Co., '93 to date. Toledo, Ohio.

EDMUND S. C. MAY, (Civil). Engr. Corps, A. T. & T. R. R., '90-2. Mech. Engr. Chicago Tel. Co., '92-5. Dist. Insp. Am. T. & T. Co. New York, N. Y.

ELMER H. NEFF, (Mechanical). M. Am. Soc. M.E. Const. Engr. E. P. Allis Co. Chf. D'ftsman Gisholt Machine Co. Do. Tool Dept. Westinghouse Mach. Co. Do. West. Gas. Const. Co. Instr. Mech. Eng. Purdue Univ. Designer Brown & Sharpe Mfg. Co. N. Y. Represent. Brown & Sharpe. New York City.

JAMES B. NELSON, (Civil). Survey S. E. Kentucky, '90-1. Engr. Bdge. & Struct. Iron Wks., Chicago, '90-4. Civ. and Cons. Engr., '94 to date. Indianapolis, Ind.

LOUIS C. SABIN, (Civil). C.E., '94. Assoc. M. Am. Soc. C.E. Asst. Engr, Merchants Bdge. U. S. Asst. Engr. St. Mary's Falls Canal Imp., '90-3. U. S. Asst. Engr., '93 to date. Port Huron, Mich.

GEORGE B. SPRINGER, (Civil). Asst Engr. W. Chicago Park Com. Bdge. Insp. I. C. R. R. Civil Engr. Chicago Edison Co. Chicago, Ill.

Irving M. Wolverton, (Civil). Assoc. M. Am. Soc. C.E. Dftsman King Bdge. Co., '90–4. Chief Engr. New Columbus Bdge. Co., '94–9. Do. Mt. Vernon Bdge. Co. Mt. Vernon, Ohio.

1891.

George R. Brandon, (Mechanical). Jun. Am. Soc. Mech. E. Chief Dftsman. Whiting Foundry Equipment Co. Asst. Engr. do. Engr. do. Harvey, Ill.

Alfred S. Calkins, (Civil). Engr. Corps E. J. & E. R. R., '91–2. Asst. City Engr. Joliet, Ill.

Dwight B. Cheever, (Mechanical). LL.B., '96. Mech. Engr. C. & W. M. and D. L. & N. Rys., '91–2. Asst. in Elec. Eng. Ansona Elec. Co., Chicago, '93. Mgr. and Elec. Engr. Wirt Elec. Eng. Co., Chicago and Phila. Atty at Law. Chicago, Ill.

James M. Crosby, (Electrical). Engr. Valley City Mill. Co., '91–3. Supt. Model Mills, '92–3. J. S. Crosby & Co., Ins. & Real Estate. Grand Rapids, Mich.

Clarence E. DePuy, (Mechanical). Jun. Am. Soc. Mech. E. Instr. in Machine Shop, Chicago Manual Training Sch., '91–6. Supt. Shops Lewis Inst., '96. Asst. Prof. Mech. Eng. do. Chicago. Ill.

Bernard L. Green, (Civil). Asst. Engr. Merchant's Bridge, St. Louis. Do. Terminal Ry. Eng. Sec'y. E. L. Corthell, '91–2. Asst. Chf. Engr. Tehuantepec Natl. R. R., '93. Asst. Engr. Congress'l Library. Asst. Engr. N. O. Bdge. Asst. Engr. Osborne Co., '94–6. Member of Firm do. '98 to date. Cleveland, O.

Harry J. Hatch, (Civil). Asst. to Patton & Frank, Duluth, '91. Cashier Farmer's Nat. Bk. Arkansas City, Kas.

*William J. Hinkson, (Civil). B. S. (Mich. Agl.) Died at Detroit, Oct., '91.

John T. N. Hoyt, (Civil). Assoc. M. Am. Soc. C.E. Dftsman. Pencoyd Bdge. Co. Do. Brooklyn Elev. R. R. Do. L. L. Buck, N. Y. Do. R. P. & J. H. Staats. Do. Metropolitan Traction Co. New York, N. Y.

William T. Keating, (Civil). With C. & N. W. R. R., '91–2. Asst. Engr. San. Dist., Chicago, '92. Chicago, Ill

Robert P. Lamont, (Civil). Eng. Dept. World's Fair, '91. Sec. and Engr. Shailer & Schniglau Co., Contractors, '92–8. Manager Simplex Ry. Appliance Co. Chicago. Ill.

Edward J. Murphy, (Civil). Asst. Engr. Sanitary Dist. Chicago, Ill.

Frederick S. Richmond, (Electrical). Elec. Engr. E. G. Barrett, Chicago. Do. L. L. Comstock Co. Chicago, Ill.

GEORGE H. ROWE, (Electrical). Asst. in Phys. U. of M., '91–2. Instr. Elec. Eng. U. of M. Prof Phys. Univ. of Colo., '93–5. Prof. Elec. Eng. '95 to date. Boulder, Colo.

ROBERT L. SACKETT, (Civil). C.E., '96. U. S. River Imp., '91. Prof. Applied Math., Earlham Coll. Richmond, Ind.

GABRIEL C. TUTHILL, (Civil). Asst. Bridge Engr. M. C. R. R. Detroit, Mich.

GEORGE M. WALKER, (Civil). Div. Engr. A. T. & S. F. R. R. Do. K. C. C. & S. R. R. Do. G. C. & S. F. R. R. Res. Engr. J. S. E. & I. R. R., '91–4. City Engr. Argentine, Kan., and Asst. Engr. and R'dmaster Kan. City Belt R. R. Kansas City, Mo.

THOMAS L. WILKINSON, (Mechanical). Jun. Am. Soc. Mech. Engrs. D'ftsman M. C. Bullock Co., Chicago. Do. Ill. Steel Co., Joliet. Inspector Machinery do. Mech. Engr. and Editor Mech. Eng. Dept. "Mining Industry and Review." Cons. M. E. Denver, Colo.

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JOHN R. ALLEN, (Mechanical). M.E., '96. Jun. Am. Soc. Mech. E. Const. Engr. Bay City Ind. Wks. Sec'y. L. K. Comstock Co. Cons. Engr. Chicago. Inst. Mech. Eng. U. of M. Ann Arbor, Mich.

ELMER L. ALLOR, (Civil). LL.B., '95. Inst. Astronomy U. of M. '92–3. Recorder U. S. Lake Survey, '91–4. Atty. at Law. Detroit, Mich.

THOMAS E. BARNUM, (Electrical). D'ftsman Gen. Elec. Co. Do. Chicago Edison Co. Do. West. Elec. Co. Do. Crane Elevator Co. Chicago, Ill.

WILLIAM BASSETT, (Mechanical). With Shaw Elect. Crane Co., '92. Chief D'ftsman Mech. Eng. Dept. Bay City Ind. Wks. Bay City, Mich.

IRVING D. CARPENTER, (Civil). D'ftsman Detroit Bdge. Wks. Do. Am. Bdge. Wks. Do. Elmira Bdge. Co. Do. Keystone Bdge. Wks. Dental Student, U. of M., '98–9. Ann Arbor, Mich.

EDWIN H. CHENEY, (Electrical). With Chicago Edison Co., '92–8. Mngr. Mut. Elect. Co. Chicago, Ill.

ELEZAR DARROW, (Electrical). Electrician, N. W. Thompson-Houston Co., St. Paul. Elect. Supt., Cinn., Newport & Cov. St. Ry. Co., Cinn. & Dayton St. Ry. Co. and Cinn. & Rosedale Ry. Gen. Supt., Cinn. Edison & Queen City Elec. Co.'s. Cincinnati, O.

ARTHUR FRANTZEN, (Mechanical). Assoc. M. Am. Inst. E.E. Dftsman, Fraser & Chalmers, '92–3. Insp. Arc Lamps Columbian Exp., '93–4. Elec. Engr. and Contractor, '94 to date. Chicago, Ill.

JAMES N. HATCH, (Civil). Mech. Dftsman. Phila., '92–3. Instr. Math. and C.E., Mich. Agrl. Coll., '93–4. Asst. Engr. M. of W., C. C. C. & St. L. R. R., '94–5. Struct. Dftsman. Carnegie Steel Co., '95–7. Do. Pittsburgh Bdge. Co., '97 to date. Pittsburgh, Pa.

CHARLES A. HOWELL, (Mining). Asst. Mgr. W'n. Canal Const. Co. Transitman U. S. Eng. Corps. Mgr. Metallic Goods Mfg. Co. Atty. at Law. Detroit, Mich.

*WILLIAM M. JOHNSTONE, (Mechanical). Asst. Engr. Globe Iron Wks., Chicago. Eng. Dept. Col. Fuel and Iron Co. Died at Hamilton, Ill., Sept., 1898.

JOHN P. KEYES, Ph.B., (Mechanical). Mech. Engr. St. Paul, Minn.

WILLIAM B. LARRABEE, (Electrical). Asst. Engr. U. S. Top. Survey, Elect. Gray Natl. Telautograph Co., '92 to date. New York, N. Y.

ALFRED C. LEWERENZ, A.B., '91, (Civil). Jun. Am. Soc. C.E. Dftsman Detroit Bdge. Wks., '92. Chief Dftsman. C. & W. M. and D. L. & N. R. R., '92–3. Asst. Engr. B. R. & P. R. R., '94–8; U. S. Bureau Yards and Docks, Wash., '94–9; Civ. Engr. U. S. N., '99. Washington, D. C.

ARTHUR D. MOTT, (Civil). Chief Dftsman. E. T. Harris Architectural Iron Wks., '93. With Purdy & Henderson, '92–8. Rosencrans & Mott, Cons. Engrs., '98 to date. Chicago, Ill.

ADNAH C. NEWELL, (Electrical). In Charge Man. Train. Dept. Pueblo H. S., '92–4. Prof. Mech. Drawing and Man. Train., Des Moines H. S., '94 to date. Des Moines, Ia.

WALTER W. SEYMOUR, (Civil). Asst. on City Engr. Corps, Grand Rapids. Do. Duffield & Son, Pineville, Ky. Dftsman. Chicago Bdge. Wks. Do. Am. Bdge. Wks., '93 to date. Chicago, Ill.

ALBERT H. SMITH, (Civil). Dftsman. Toledo Bdge. Co., '92–9. Toledo, O.

EDWIN M. SMITH, (Civil). Asst. Engr. M. C. R. R., '92–3. Asst. Engr. Sewer Dept., Chicago. Drainage Canal, '93–4. Asst. Engr. St. Dept., Chicago, '94–7. Cleveland Mngr., Am. Luxfer Prism Co., '97–8. Gen. Mngr. Electric Co., '99. Cleveland, O.

HUGH F. VAN DEVENTER, (Mining). Prest. Georgia Slate Co. and Vice-Prest. Gt. Southern Consolidated. Knoxville, Tenn.

GEORGE M. WISNER, (Civil). Sub Asst. Engr. San. Dist. Chicago, '92–7. Asst. to Chief Engr. do., '97 to date. Chicago, Ill.

1893.

CHARLES G. ATKINS, (Electrical). First Asst. Engr. Tests, Westinghouse E. & M. Co., '93–5. Const. Eng. do. New England Dist. Supt. Chicago Edison Co.'s Shops. Chicago. Ill.

HADLEY BALDWIN, (Civil). Asst. Engr. Maint. of Way, C. C. C. & St. L. R. R., '93–6. Supervisor Track do. Engr. M. of W. do. Indianapolis, Ind.

JOHN Y. BLACKWOOD, (Mechanical). Dftsman. F. N. Dunlap. Do. Rogers Typo. Co. Do. Merganthaler Linotype. Brooklyn, N. Y.

WILL H. BOUGHTON, (Civil). C.E., '98. Asst. Engr. C. C. C. & St. L. Ry. Dftsman. N. Jersey Steel Co. Do. Pittsburgh Bdge. Co. Do. Brown Hoist. and Convey. Mach. Co. Inst. Math. and Science, Denison Univ. Granville, O.

HARRY O. CHANNON, (Electrical). Secy. and Mgr. Empire Light and Power Co. Quincy, Ill.

ALBERT L. CLARK, (Mechanical). Mech. Engr. Wm. E. Hill Co., Kalamazoo, '94–5. Dftsman. Bay City Ind. Wks. With Mo. Riv. Com. Supt. Bldg. Const., '95–7. Dftsman. Detroit Dry Dock Co., '97–8. Inst. Man. Training. Laurimer, Mich.

WILLIAM J. CURRER, (Civil). Salesman Bishop Co. Los Angeles, Cal.

JASPER C. DAVIS, (Civil). Asst. City Engr. Lansing, '93–5. City Engr. '95–9. Lansing, Mich.

WILLIAM H. DORRANCE, JR., (Mechanical). Asst. to Prof. M. E. Cooley, '93–5. Dftsman. Stirling Co. Barberton, O.

JOHN D. E. DUNCAN, (Electrical). Assoc. M. Am. Inst. E.E. Elec. Engr. Stanley Mfg. Co. Pittsfield, Mass.

GRANT H. DUNNING, (Civil). Co. Surveyor, '93–5. Teaching, '95–7. Asst. U. of M., '97–8. Instr. Math., Dowagiac H. S., '98 to date. Dowagiac, Mich.

HENRY G. FIELD, (Electrical). Engr. Elect. Subway, Columbian Exposition. Elec. Inspector Mich. Insp. Bureau. Agt. Electric Service Co. Field & Hinchman, Cons. Elect. and Mech. Engrs., '94 to date. Detroit, Mich.

WILL J. FISHER, (Electrical). Engr. P. & S. L. Electric R. R. City Engr. Pontiac. Chf. Const. Engr. F. & C. R. R. Pontiac, Mich.

PHILIP S. GARDINER, (Mechanical). Lumber Dealer. Laurel, Miss.

GEORGE I. GAVETT, (Civil). U. S. Insp. Dredging '93–4. Dftsman. Instr. Math. and Sc., Spring Arbor Sem., '97 to date. Sandstone, Mich.

FRANK R. GILCHRIST, (Civil). Lumber Dealer. Cleveland, Ohio.

HERBERT J. GOULDING, (Mechanical). Inst. Drawing, U. of M. Ann Arbor.

LEON M. GROESBECK, (Mining). With Chicago Carpet Co. Chicago, Ill.

LEONARD F. W. HILDNER, (Mechanical). Inst. in Math. Detroit H. S., '94. Dftsman. Detroit Bdge. Wks., '94–6. Chf. Dftsman Riter-Conley Co. Allegheny, Pa.

THEODORE H. HINCHMAN, (Mechanical). A.B., '91. Jun. Am. Soc. Mech. E. Asst. to Prof. Cooley. Do. Jesse M. Smith. Dftsman. M. C. R. R. Cons. Engr., Field & Hinchman. Chf. Machinist, U. S. S. Yosemite. Detroit, Mich.

JOSEPH S. H. HOLMES, (Mechanical).

ALFRED W. HOOKWAY, (Electrical). Merchant. Owosso, Mich.

*HIRAM HOWDEN, (Mechanical). Died at Silver Springs, N. Y., '94.

CLARENCE W. HUBBELL, (Civil). Chf. Dftsman. Water Office, '93–8. Civil Engr. Do., '98 to date. Detroit, Mich.

MELBURN W. HULL, (Mechanical). Dftsman Bay City Ind. Wks. Instr. Pueblo H. S. Pueblo, Colo.

VALENTINE S. IVES, (Civil). Dftsman. Toledo Bdge. Co., '93–5. Civil Engr. for A. P. Ruggles. Computing, King Bdge. Co., '95. Asst. Engr. Co. Surveyor's Office, Cleveland, '95–8. Treas. J. F. Hartz Co., '98 to date. Detroit, Mich.

CARROLL D. JONES, (Electrical). E.E., '97. Instr. Elect. Eng. U. of M. Ann Arbor, Mich.

FRED L. KEELER, (Electrical). Grass Lake, Mich.

ALERED C. MARSHALL, (Electrical). Asst. Elec. Insp. Mich. Insp. Bureau, '93–4. Elect. and Supt. Lines Pub. Lighting Com., '94 to date. Detroit, Mich.

GEORGE H. MILLER, (Electrical). D'ftsman, F. B. Rae. Supt. Royal Cycle Wks., '94. Prof. Sci., Marshall H. S., '94–8. Instr. Sci., Blue Island H. S. Blue Island, Ill.

JOSEPH J. MORSMAN, (Civil). Asst. Stat'y Engr. Carter White Lead Co., Omaha, '93. Asst. Supt. do., '93–4. Supt. of Cons. do., Chicago, '94–5. Mngr. do., '95. Secy. do., '96 to date. Chicago, Ill.

LLEWELLYN S. POMEROY, (Civil). U. S. Sub. Insp. Masonry, St. Mary's Falls, '92. Asst. Engr. Sewers, Dayton, O., '93. Instr. Mech. Drawing, Y. M. C. A., '96–7. Kalamazoo, Mich.

MINOTT E. PORTER, (Civil). C.E., '98. Dftsman. Sears Typo-Matrix Co., Cleveland, '94–7. Computer Hydrographic Office, Navy Dept. Do. U. S. Naval Observatory, '97 to date. Washington, D. C.

HOWARD M. RAYMOND, (Electrical). Instr. Physics, Armour Inst. Tech. Chicago, Ill.

EDWARD S. REID, (Mechanical). Jun. Am. Soc. Mech. E. Asst. to Prof. Cooley, '94. Chf. Dftsman. Whiting Fndry. Equipment Co. Harvey, Ill.

HUGH RODMAN, (Electrical). Dftsman. Coast Survey, Alaska, '93–6. Min. Engr. Alaska, '96–7. Gen. Mngr. C. I. Min. Co., '97 to date. Frankfort, Ky.

EDWIN J. ROSENCRANS, (Civil). Dftsman., J. H. Gray, '95. Do. Purdy & Henderson, N. Y., '95–7. Engr., Green & Wicks, Archts., Buffalo, '98. Rosencrans & Mott, Engrs., '99 to date. Chicago, Ill.

WILLIAM W. TAYLOR, (Mining). Chemist Ills. Steel Co., '94. Chemist Mo. Furnace Co. St. Louis, Mo.

OTTO L. E. WEBER, (Mechanical). Jun. Am. Soc. Mech. E. Supt. Mich. Sulphite Fibre Co. Port Huron, Mich.

EDWARD D. WICKES, (Electrical). Gen. Engr. Chicago, Ill.

NEIL H. WILLIAMS, (Electrical). M.S., '95. Supt. Clinton Elec. Co., '93–4. Prof. Sci., W. Bay City H. S., '95–7. Prin. do., 97–8. Instr. Phys. and Chem., Central H. S., Detroit, '98 to date. Detroit, Mich.

FRANK A. WINDES, (Mechanical). Survey Transp. Bldg. Columbian Exposition. Asst. Supt. Pub. Wks. Bldg. Contractor, '93. Asst. Engr. Winnetka, Ill., '94–6. With Bowen and Anderson, City Engrs., Waukegan and Lake Forest Co. City Engr. Winnetka and Glencoe, and Instr. Man. Training, Public Sch. Winnetka, Ill.

CLARENCE G. WRENTMORE, (Civil). M.S., '98. Instr. Descriptive Geometry and Drawing, U. of M. Ann Arbor.

1894.

ABRAHAM K. ADLER, (Mechanical). With McDonald Eng. Co. '94–5. Asst. to Chf. Engr., Crane Elevator Co., '95–6. Mech. Engr. with D. Adler, Arch., '96–9. Chicago, Ill.

ROBERT L. AMES, (Mechanical). Dftsman. St. Ry. Co., Grand Rapids. Do. City Engr. Office, Kalamazoo, '92. U. S. Lake Survey, '93–4. Asst. Exam. Patent Office, '94 to date. Washington, D. C.

ARCHIBALD L. BECKER, (Mechanical). Dftsman. Montague Iron Wks., '94 to date. Montague, Mich.

JOHN C. BIRD, (Mechanical). Dftsman. Kalamazoo Ry. Velocipede & Car Co., '94. Do. Fox Machine Co., '94–7. Do. Geo. D. Walcott & Son, Jackson, '97. Do. Niagara Machine & Tool Co., Buffalo, '97–8. Do. Brown & Sharpe. Providence, R. I.

JAMES BLAIR, (Mechanical). Asst. to Prof. Cooley, '94–5. Dftsman. D. H. Burnham & Co., Arch. Do. Hawley Downdraft Furnace Co., Chicago. Santa Marta, Columbia, S. A.

HOWARD E. CHICKERING, (Mechanical). Dftsman. Detroit Bdge. Wks., '96. American Bdge. Wks., '96–7. Gas Engine Expert, Fairbanks, Morse & Co. Kansas City, Mo.

HARRY W. CLARK, (Mechanical). Asst. Nat. Blower Co., '95. D'ftsman, E. E. Myers, Arch. Supt. Hospital, U. of M. Ann Arbor.

WILLIAM C. CONANT, (Mechanical). Dftsman. Chicago Screw Co. Do. Fraser & Chalmers. Machinist Am. Spring Co. Die and Tool Maker, Moon Mfg. Co. Oak Park, Ill.

CLARENCE S. COOK, (Electrical). Prof. Physics, H. S. Detroit, Mich.

ALMON H. DEMRICK, (Electrical). With Field & Hinchman, '94–5. Supt. & Engr., Scott Bros. Elec. Co., '95–6. With Hunt Air Brake Co., '96–7. Fisher Elec. Co., '97. Elec. Contractor, '97 to date. Detroit, Mich.

HERMAN H. EYMER, (Mechanical). Dftsman. Detroit Bdge. Wks., '94–5. Do. American Bdge. Wks. Asst. Engr. Saginaw '96–9. Saginaw, Mich.

HERBERT E. FRENCH, (Civil). Asst. Supt. Woolen Mill, '94–7. Asst. Engr. C. & N. W. R. R., '97–9. Reedsburg, Wis.

OSCAR GREULICH, (Civil). Arch. Dftsman., '94–5. Do. Nat. Blower Co. Do. Illinois Steel Co. (Milwaukee), '96. Heating & Ventilating Engr., '96 to date. Milwaukee, Wis.

JOHN C. HAMMOND, (Mechanical). Asst. on Nautical Almanac. Washington, D. C.

HARRIE D. HAMPER, (Mechanical). Asst. D. L. Barnes, Cons. Eng. With West. Wheeled Scraper Co. Aurora. Ill.

CHARLES J. HARMON, (Electrical). Asst. to Chf. Engr. M. of W., S. E. R. R. With Morgan & Wright, '97–8. Do. Ames & Frost, '98 to date. Chicago, Ill.

GEORGE HAYLER, JR., (Mechanical). Supt. Elect. Light & Power Co. 2d Ohio Inf., '98. Van Wert, O.

MAX LICHTENSTEIN, (Civil). Civil Engr. Elgin, Ill.

DANIEL B. LUTEN, (Civil). Inst. Civil Eng. U. of M., '94–5. Do. Arch. & San. Eng. Purdue Univ., '95 to date. LaFayette, Ind.

RALPH W. NEWTON, (Civil). Dftsman Detroit Bdge. Wks., '94–5. Do. Columbus Bdge. Wks., '95. Do. Carnegie Steel Co. Pittsburg, Pa.

FREDERICK C. NOBLE, (Civil). Prin. Asst. Engr. C. S. & S. W. R. R. Engr. Green & Wicks, Archts. Dftsman Purdy & Henderson, C.E. New York.

ROBERT K. PALMER, (Civil). Dftsman Am. Bdge. Wks., '94. Do. New Columbus Bdge. Co., '95. Do. Elmira Bdge. Co. Do Hamilton Bdge. Wks., '96 to date. Hamilton, Ont.

William P. Parker, (Civil). Dftsman Detroit Heating & Lighting Co. Do. Detroit Metal and Heating Co. Do. Detroit Dry Dock Co. Do. Kenwood Bdge. Co. Do. Whiting Fdry. Equipment Co. Do. Massillon Bdge. Co. Do. Pittsburg Bdge. Co. Do. Carnegie Steel Co. Do. Keystone Bdge. Wks. Color Sergt. 1st U. S. Vol. Engrs.

Richard Quinn, (Civil). Asst. U. S. Engr. Corps, Miss. River Imp. Do. in charge Fortifications Forts St. Philip and Jackson. Fort St. Philip, La.

Oscar Roberts, (Civil). Missionary, Batanza, W. Africa. Johannesburg, S. Africa.

Fred Rogers, (Electrical). Electrician Vermillion Milling & Electric Co., '95-6. Instr. Elect., Lewis Inst. Chicago, Ill.

Fred A. Sager, (Electrical). Asst. Physics, '94-5. Instr. Physics, '95-6. Asst. Physics, Univ. of Ill., '96 to date. Urbana, Ill.

William S. Smith, (Mechanical). Aurora, Ill.

Goldwin Starrett, (Mechanical). Arch. Dftsman D. H. Burnham & Co. Supt. Fuller Const. Co., Pittsburg. Santa Marta, Columbia, S. A.

George C. Weare, (Mechanical). With Sherwin Williams Co., Paint and Color Mfrs. Cleveland, O.

Joseph Weare, (Civil). Dftsman New Columbus Bdge Co. Do. Hamilton Bdge. Wks. Do. Mt. Vernon Bdge. Wks. Mt. Vernon, O.

1895.

Louis W. Anderson, (Civil). Recorder U. S. Harbor Surveys, '95. Insp. do., '95-6. Asst. City Engr. Grand Rapids, '97 to date. Grand Rapids, Mich.

Walter M. Austin, (Electrical). Philadelphia, Pa.

William G. Billings, (Electrical). Asst. to R. R. Commissioner, '95-7. Engr. Chase Constr. Co., '97 to date. Grand Rapids, Mich.

August Blaess, (Civil). Asst. Eng. Corps, D. & M. R. R., '95-6. Do. Penns. Co., '98. Do. I. C. R. R., '98 to date. Chicago, Ill.

Abraham L. Burgan, (Electrical). M.S. '96. Asst. Elect. Dept. Calumet & Hecla Mining Co., '91-2. Post-Graduate, U. of M., '95. Supt. Tamarack & Osceola Stamp Mills. Lake Linden, Mich.

*****Platt R. Bush**, (Civil). Levelman Munsing R. R., '95. Asst. Engr. Lehigh Valley Coal Co's. Docks. Died at Detroit, Oct. '98.

William R. Caldwell, (Civil). Asst. City Engr. Sault Ste. Marie, Mich.

Wallace W. Chickering, (Mechanical). Dftsman Gas Engine Wks., '95-7. With Fairbanks, Morse & Co., '97 to date. Beloit, Wis.

HOWARD M. COX, (Mechanical). Dftsman Denver Engineering Wks., '95–6. Do. Chisholm, Boyd & White Mach. Co., '96–7. Do. Chicago Edison Co., '97. Cost Dept., Gates Iron Wks., '97–8. Solicitor of Patents. Chicago, Ill.

GEORGE A. DAMON, (Electrical). Assoc. M. Am. Inst. E. E. Asst. to B. J. Arnold, Electric Engr, '95 to date. Chicago, Ill.

JAMES H. DICKSON, (Electrical), A.B., '94. Asst. to Field & Hinchman Elec. Engrs. Detroit, Mich.

JAMES H. DUNBAR, (Civil). Dftsman. New Columbus Bdge. Co. Columbus, O.

JOHN H. DYE, (Civil). Engr. to Kingdom of Korea. Seoul, Korea.

HARVEY G. GILKERSON, (Civil). Eng. Corps, St. L. & K. C. R. R., '95. Transitman Col. Spr. & C. C. R. R. • Colorado Springs, Colo.

R. PROSPER GUSTIN, (Mechanical). Jun. Am. Soc. C.E. Dftsman. Baldwin Loco. Wks. Asst. Engr. Degnon-McLean Constr. Co. Brooklyn, N. Y.

ALEXANDER M. HAUBRICH, (Electrical.) Supt. Water Wks. Amherstburg, Ont., '93–5. Electric Light and Telephone Const., Detroit, '95. Do. Toledo, '96. E. Engr. Central Union Telephone Co., '97. Chicago, Ill.

BRYSON D. HORTON, (Electrical). Foreman, Bartlett Ill. Co., Saginaw, '95–6. Asst. Engr. Park and Boulevard Com., Detroit, '96–7. Electrician Pub. Light Com., '97. Chf. Electrician, U. S. S. Yosemite. Detroit, Mich.

JOHN HULST, (Mechanical). Dftsman. and Estimator, Whiting Foundry Equipment Co. Harvey, Ill.

MILTON B. HUNTOON, (Electrical). Teacher H. S. Menominee, Mich.

CLARENCE T. JOHNSTON, (Civil). Eng. Corps. State of Wyoming. Irrigation and Reservoir Wk. Stream gauging U. S. Geol. Survey. Asst. State Engr. Cheyenne, Wyoming.

HORACE W. KING, (Civil). Minneapolis, Minn.

HARRY V. KNIGHT, (Electrical). Instr. Sc., Alpena H. S., '96 to date. Alpena, Mich.

DAVID LA FAVOUR, (Civil). Grad. Student U. of M., '96. Dftsman., D. & M. Ry., '96–8. Treas. Bay City Round Hoop Co., '98 to date. Bay City, Mich.

HERMAN B. LEONARD, (Electrical. With Toledo Elec. St. R'y., '95. Dftsman. & Engr. Bissell, Dodge & Erner Co. Instr. Math. Kalamazoo H. S., '96–8. Instr. Physics, Racine H. S. Racine, Wis.

RICHARD R. LYMAN, (Civil). Prof. Math. and Eng., Brigham Young Academy. Provo, Utah.

Thomas K. Mathewson, (Civil). Inspector Miss. River Imp., '95. Asst. to City Engr., Muscatine, Ia. Gran Pacifico R. R. Surveys, Mexico.

William J. Melchers, (Electrical). Elect. Engr. Telephone Exch., '95-8. Mgr. Valley Telephone Co. Saginaw, Mich.

Charles A. Miner, (Civil). U. S. Asst. Engr. Fortifications, Mouth Miss. River. First Lt. 3d U. S. Vol. Engrs. Macon, Ga.

Charles H. Morse, Jr., (Mechanical). M.E., '97. Asst. Mfg. Dept., Fairbanks, Morse & Co., '97. Sales Dept. do., '98. Mech. Engr., do., '99. Chicago, Ill.

John F. Nichols, (Mechanical). Machinist, F. W. Wheeler Co., '95. Dftsman. do., '95-7. Do. Bay City Ind. Wks., '97-8. Do. Newport News Ship Build. & Dry Dock Co., '98 to date. Newport News, Va.

Elbert Nicholson, (Mechanical). Asst. G. S. Pierson. Asst. to City Engr., Sterling, Ill. With John A. Cole, Civ. Engr. Chicago, Ill.

Marian S. Parker, (Civil). Struct. Eng. Purdy & Henderson, '95 to date. New York.

Albert S. Passolt, (Electrical). Asst. to Prof. Carhart, '95-6. Elect. with Field & Hinchman, Detroit, '96. Do. Bartlett Illum. Co. Saginaw, '96-7. Do. U. of M., '97. Supt. Elec. Light Co., '98 to date. Columbus, Miss.

*__Clarence H. Perry__, (Civil). Eng. Corps, Chicago N. Side R. R. Died at Chicago, March, 1896.

Seth E. Roberts, (Civil). Dftsman. with W. H. Ashwell & Co. Do. King Bdge. Co., '96-7. Do. Webster, Camp & Lane, '98. Do. Detroit Bdge. Wks., '99. Detroit, Mich.

Wilbur G. Salter, (Mechanical). Dftsman. Andrews & Johnson, Heat and Vent. Engrs., '95. Dept. Mgr., Gen. Mgr., Sec. & Treas. Troy Baky. Co., '96. Bicycle Sundries, etc., '98. Chicago, Ill.

William Schaake, (Mechanical). Dftsman, Kenwood Bdge. Co., '95. Designer, Sligh Bicycle Co., '96. Dftsman. Shaw Elec. Crane Co., '97-8. Crane Dept. Pauling & Harnischfger, '98 to date. Milwaukee, Wis.

Emmet Scott, (Mechanical). Stationary Engr., '95. Asst. in Office. Bookkeeper Niles & Scott Co. La Porte, Ind.

Frederick G. Skinner, (Civil). Dftsman and Transitman, Metrop. St. Ry. Kansas City, Mo.

Lester A. Stanley, (Electrical). With Karoly Elec. Co., and Amer. Gas Engine Elec. Co., Chicago, '95-6. Instr. Physics and Elec. Eng. Provo City, Utah.

ISAAC F. STERN, (Civil). With Wm. Sooy Smith, '95. Dftsman with Purdy & Henderson. Chicago, Ill.

EDWARD M. ST. JOHN, (Civil). U. S. Insp. Masonry, St. Mary's Falls, Canal, '92-3. Asst. Engr. L. S. & M. S. R. R., '95-8. Dftsman Mo. Valley Bdge. Works, '98 to date. Leavenworth, Kan.

ROBERT C. STEVENS, (Mechanical). A.B., '94. Mech. Engr. with Atlas Iron Wks. Indianapolis. Inst. Mech. Eng. U. of M., '98 to date. Ann Arbor, Mich.

WELLINGTON C. TATE, (Electrical). Supt. Const. Ohio Penitentiary. Mansfield, Ohio.

NELSON J. TUBBS, (Civil). Dexter. Mich.

FRANK F. VAN TUYL, (Electrical). With Gilbert Wilkes, '95-6. Bissel, Dodge & Erner Co., Toledo, '97-8. B. J. Arnold, Chicago, '98. Electrician D. Y. & A. A. Ry., '98 to date. Ypsilanti, Mich.

VANCE P. WILKINS, (Civil). Dftsman to City Engr., Akron, O. Asst. Engr. St. L. & S. W. R. R. Texarkana. Texas.

GEORGE B. WILCOX, (Mechanical). Testing Engr. F. W. Wheeler & Co., '95. Engine Designer do., '96. Engr. and Pat. Solicitor, '97 to date. Instr. Mech. Eng. U. of M. '98. Bay City, Mich.

HOMER W. WYCKOFF, (Electrical). Supt. Const. Conduits for City Lighting, Detroit, '94. Do. Cen. Union Telephone Co., Toledo, '95. Asst. Engr. do., Chicago. Engr. Constr. Conduits, Indianapolis, '96. Chicago, Ill.

1896.

MORTIMER G. BARNES, (Civil). U. S. Insp. Masonry St. Mary's Falls Canal Lock, '96. Asst. Engr. L. Superior Power Co., '96-7. U. S. Survey Birmingham Canal, Ala., '97-8. Engr. Chandler & Dunbar Power Co., Sault St. Marie, '98. Instrumentman U. S. Deep Waterways, '98 to date. Valleyfield, P. Q. Can.

WILLIAM C. BORST, (Electrical). Engr. Corps D. & R. G. R. R., '96. Instr. Physics and Drawing, Man. Training H. S. Denver, Col.

HARRY C. BUELL, (Mechanical).

WALTER T. CAHILL, (Civil).

WILLIAM A. CALDWELL, (Electrical). With Bell Tel. Co., '96-8. Missouri Edison Co., '98 to date. St. Louis, Mo.

BURNHAM S. COLBURN, (Civil). Dftsman Detroit Bdge. Wks., '96-7, '99 to date. Res. Engr. Victoria Bdge, Montreal, '97-9. Detroit, Mich.

PHILIP R. COATES, (Electrical). Dftsman Merrimack Mfg. Co., '96 to date. Lowell, Mass.

JOHN C. CONDON, (Electrical). Dftsman Portage Lake Foundry & Mach. Co., '97–8. Do. Hecla Mining Co., Calumet, Mich.

JESSE I. CONKLIN, (Civil). U. S. Insp. Masonry, Sault Ste. Marie, '92–6. Overseer Fort St. Philip, La., '96–7. Chf. Insp. Plaquemine Locks, '97. Jun. Engr. do. '97 to date. Plaquemine, La.

MERRITT S. CONNER, (Electrical). Elec. Engr. with Western Electric Co., '96. Chicago, Ill.

WILLIAM C. CORYELL, (Mechanical). Machinist M. C. R. R., '96–8. Dftsman. Baldwin Loco. Wks., '98. Do. L. S. & M. S. Ry. Do. Otis Steel Co. Youngstown, O.

FRED R. CUTCHEON, (Electrical). With Western Elect. Co., '97. Electrn. St. Paul Elect. Lt. Wks., '97 to date. Sergt. Co. G. 2d U. S. Vol. Engrs. St. Paul, Minn.

FRED A. ECKERT, (Mechanical). Instr. Machine Shop, Man. Train. Sch., '96. Chicago, Ill.

CHARLES W. ELLIS, (Electrical). Bell Tel. Co., Chicago. Gas Engine Dept., Fairbanks, Morse & Co., Beloit, Wis. Westinghouse Mach. Co. Pittsburgh, Pa.

CHARLES M. EDDY, (Mechanical). With Toledo Traction Co., '96–8. Eddy & McColl, Elect. Engrs. & Contr. 10th Ohio Inf. Toledo, O.

JAY D. EDMONDS, (Mechanical). Chf. Dftsman. Chicago Screw Co., '98. Mech. Engr. Fischer Equipment Co. Edmonds & Metzel. Chicago, Ill.

RICHARD D. EWING, (Civil). Instr. Math., Ishpeming. Supt. Schools. Champion, Mich.

THOMAS H. FERGUSON, Ph.B., '95, (Civil). Draftsman. Pub. Light Com'n, Detroit, '96–7. Contractors' Engr. Monongahela Navigation Impt., '97–8. Asst. Examiner Patent Office. Washington, D. C.

JOHN W. FITZGERALD, (Mechanical). E.E. (Mass. Inst. Tech.), '97. Western Elect. Co., '97–9. FitzGerald & Marquardt Eng. Co. San Juan, Porto Rico.

BURT L. FOSTER, (Mechanical). Ann Arbor, Mich.

SERGIUS P. GRACE, (Electrical). Chf. Engr. New State Tel. Co. Detroit, Mich.

ALBERT E. GREENE, Ph.B., '95, (Civil). Cement Tests, Herr's Isl. Dam, '96. Asst. U. of M., '96–7. Dftsman. Detroit Bdge. Wks., '97–9. Asst. Engr. M. of W., M. C. R. R., '99. Detroit, Mich.

DWIGHT M. GUILLOTTE, (Mechanical). With Master Mech. and Erecting Dept. Ann Arbor R. R. Owosso, Mich.

PAUL HAMILTON, (Civil). Kingston, Ill.

GEORGE H. HARRINGTON, (Civil). Titusville, Pa.

EDWARD B. HOUSE, (Electrical). Prof. Math., Col. Agl. Coll. Fort Collins, Col.

JOHN S. HOADLEY, (Civil). Eldon, O.

EDWIN D. HOYT, (Mechanical). Supt. Shops, Train. Sch., Chicago, '90–3. Instr. Man. Train. Muskegon H. S., '96–7. Prin. Hackley Man. Train. Sch., '97–9. Muskegon, Mich.

JOHN W. IRWIN, (Civil). City Engr. Mt. Clemens, Mich.

HUGH C. JACKSON, (Civil). Asst. Engr. R. H. McConaghy, Newcastle, Pa., '95–6. Dftsman. Gillette Mfg. Co. Minneapolis, Minn.

ALBERT B. KALMBACH, (Mechanical). Dftsman. Ohio Steel Co. Youngstown, O.

JULIUS KAHN, (Civil). C.E., '99. Dftsman. Union Bdge Co., '96. Asst. Engr. Bushwick Iron Wks., '97. Brooklyn Navy Yard, '97. Dftsman. C. W. Hunt Co., '98 to date. New York, N. Y.

HUGH B. KELLEY, (Civil). Elgin, Ill.

GUY T. LAMONT, (Mechanical). Mgr. Lamont's Sash and Door Factory. Bay City, Mich.

THOMAS B. LEE, (Civil). Coldwater, Mich.

CARL R. MARQUARDT, (Mechanical). FitzGerald Marquardt Eng. Co. San Juan, Porto Rico.

CLYDE S. MASON, (Mechanical). Dftsman. M. C. R. R. Shops, '96 to date. Jackson, Mich.

THOMAS D. MCCOLL, (Electrical and Mechanical). Elec. Engr. Light and Power Co., Chelsea. Do. Bissell, Dodge & Erner Co., Toledo. Eddy & McColl, Elec. & Mech. Engrs. Toledo, O.

GEORGE T. MCGEE, (Civil). Mining Engr. Leadville, '96–7. Do. S. Nevada. Do. Gt. Boulder Mines. Kalgoorlie, W. Australia.

GEORGE K. MCMULLEN, (Electrical). Citizens Tel. Co., '96. Fox Machine Co. Grand Rapids, Mich.

HERBERT W. MERRILL, (Mechanical). Machinist, Mitts & Merrill. Saginaw, Mich.

HARRY D. Y. MILLS, (Civil). Toledo, O.

GUY D. NEWTON, (Mechanical). Ann Arbor, Mich.

LEE L. NEWTON, (Civil). Lake Linden, Mich.

WALTER K. O'BRIEN, (Electrical). Chf. Engr. Am. Luxfer Prism Co., '96 to date. Chicago, Ill.

ARTHUR P. O'BRIEN, (Civil). Represent'g Amer. Luxfer Prism Co. New York, N. Y.

HENRY B. OTIS, (Electrical). Telephone Co., '97. Amer. Luxfer Prism Co., '98.

CHARLES G. PALMER, (Electrical). Detroit, Mich.

LEWIS M. PARROTT, (Electrical). Principal H. S. St. Johns, Mich.

JAMES M. RAIKES, (Civil). Burlington, Ia.

BEN C. RICH, (Civil). Instrument-man, C. H. & W. R. R., '96–8. Builder, '98 to date. Chicago, Ill.

WALTER ROBBINS, (Electrical). West. Elect. Co., '96–7. F. B. Rae Eng. Co., '97. Pierce and Richardson, '97–8. West. Elec. Co., '98. Chicago, Ill.

EDWARD J. RYAN, (Electrical). Detroit, Mich.

RICHARD E. SACK, (Electrical). Edison Illum. Co. Detroit, Mich.

FRANK C. SOPER, (Electrical). Designer, Amer. Luxfer Prism Co., '96–9. West. Elec. Co., '99. Chicago, Ill.

GEORGE R. SNOVER, (Mining). Mining Engr. San Juancito, Honduras.

CHARLES H. SPENCER, (Civil). Asst. to City Engr., Ann Arbor. M. of W. Dept., L. S. & M. S. R. R. Toledo, O.

WILL T. STEBBINS, (Electrical). Ship Bldg. & Dry Dock Co. Newport News, Va.

ADRIAN D. STEVENSON, (Electrical). Journalism. Detroit, Mich.

FRANKLIN V. V. SWAN, (Electrical). Flint, Mich.

GEORGE W. TANNER, (Electrical). Instr. St. John's Sch. Salina, Kan.

WARREN K. THOMPSON, (Mechanical). Machinist, Brown Hoist. & Conv. Mach. Co. Erector for do. Cleveland, O.

CHARLES K. VAUGHAN, Ph.B., (Hillsdale), (Civil). Dftsman. S. Halsted St. Iron Wks. Chicago, Ill.

HARRY C. WEARE, (Mechanical). Moulton Starrett Const. Co. Chicago, '96–7. Rep'g Amer. Luxfer Prism Co. Boston, Mass.

LAVERGN L. WHEELER, (Electrical). Sandstone, Mich.

FRANK S. WHITMAN, (Civil). Buchanan, Mich.

VICTOR R. WILLOUGHBY, (Mechanical). Solvay Process Co., '96–7. Dftsman. Mich. Penin. Car Co., '97 to date. Detroit, Mich.

CARL B. WILLIAMS, (Civil). Civil Eng'g. Chicago, Ill.

LOUIS A. WOODARD, (Mechanical). Loco. Shops L. S. & M. S. R. R., '96–7. Dftsman. do., '97–8. Do. Ohio Steel Co., '98 to date. Youngstown, O.

SILAS H. WOODARD, (Civil). Pneumatic Caisson Fndn. Wk., N. Y., '96–7. Purdy & Henderson, '97–8. Dutton Pneumatic Lock & Eng'g Co., '98–9. Asst. Engr. U. S. Bd. Engrs. Deep Waterways, '99. Detroit, Mich.

GROVER H. WOODS, (Electrical). State Insp. Pub. Wks., '96–8. Elec. Engr. Syracuse Const. Co., '98 to date. Syracuse, N. Y.

HENRY L. WOOLFENDEN, (Electrical). M.S., '97. With Gilbert Wilkes. Detroit, Mich.

*EDWIN F. WOODRUFF, (Mechanical). Supt. J. S. Stearns Lumber Co., Odanah, Wis. Act. Asst. Engr. U. S. N. Died at Ludington, June, '98.

1897.

FRED L. BAKER, (Mechanical). Elect. Lighting, U. of M., '97–8. Machinist, M. C. R. R. Dftsman. Loco. Wks., '98 to date. Schenectady, N. Y.

MARK BARY, (Electrical). With City Engr. St. Louis, Mo.

ARTHUR W. BIRDSALL, (Electrical). Cleveland, O.

DEWARD A. BRITTEN, (Electrical). Elect. Lighting, U. of M., '98. Mich. Elect. Co., Detroit, '98–9. With D. Y. & A. A. Ry., '99. Ann Arbor, Mich.

FREDERICK H. BURDICK, (Civil). With Riter & Conley. Pittsburgh, Pa.

MELANCTHON W. CAMPAU, (Mechanical). With Gilbert Wilkes. Dftsman. Dry Dock Co. Naval Reserves, U. S. S. Yosemite. Detroit, Mich.

RALPH COLLAMORE, (Mechanical). Dftsman. Field & Hinchman, '97. Detroit, Mich,

EMMONS COLLINS, (Electrical and Mechanical). Dftsman. Whiting Fndry. Equipment Co. Chicago, Ill.

CHARLES COTTINGHAM, B.C.E. (Purdue). C.E. City Engr. Danville, Ill.

WILBERT S. DREW, (Mechanical). Instr. Man. Train. Sch., Toledo. Arch. Dftsman. Newton, Mass.

ELMER M. ELLSWORTH, (Civil). U. S. Deep Waterways Survey, '97–8. Thornville, Mich.

THADDEUS L. FARNHAM, (Mechanical). Gas Eng. Dept., Fairbanks, Morse & Co., Beloit, '97–8. Gas Eng. Expert do., Chicago, Kansas City, etc., '98 to date. Beloit, Wis.

HENRY GEISMER, (Civil). Leveler, Birmingham Canal Survey, '97. Surveyor, Sloss Iron & Steel Co. Asst. Engr. Tallassee Falls Mfg. Co. Tallassee, Ala.

MELVIN A. GILBERT, (Civil). With Riter-Conley Mfg. Co., '98 to date. Allegheny, Pa.

HENRY T. HARRISON, (Electrical). Cleveland, O.

FREDERICK W. HENNINGER, (Electrical).

Loomis Hutchinson, (Electrical). Testing Boilers. Dftsman, Sterling Boiler Co. U. S. S. Yosemite. Barberton, O.

Carlyle Kittredge, (Electrical). With Bissell, Dodge & Erner, Toledo, '97. Asst. Engr. F. M. Dunlap, Detroit, '98. Elect. Plant, Van Wirt, O. Ann Arbor. Mich.

John G. Lewis, (Electrical). Chicago, (Oak Park).

Elmer D. Lyon, (Mechanical). Dftsman Standard Boiler & Bdge Co., Bellaire, '97. Do. Metrop. Elev. R. R., Chicago, '98. Amer. Blower Co., '99 to date. Detroit, Mich.

William F. Martin, (Mechanical). With Eng. Dept. A. T. & S. F. Ry. '97. Chanute, Kan.

John H. Montgomery, (Electrical). M. S., '98. Manuf. Elect. Supplies. Ann Arbor, Mich.

Thomas F. McCrickett, (Mechanical). Dftsman Bay City Ind. Wks., '95-6. Engr. Russel Wheel & Fndry. Co. Detroit, Mich.

Henry E. Moore, (Civil). Asst. Engr. Bdges. & Bldgs. C. & W. M., & D. G. R. & W. R. R. Grand Rapids, Mich.

Lyman F. Morehouse, (Electrical). Instr. Sc. High Sch., '97 to date. Marquette, Mich.

Charles J. H. Moritz, (Electrical). Valley Tel. Co., Saginaw. '97-8. Insp. Mich. Lake Superior Power Co., '98. U. S. S. Yosemite. Sault Ste Marie, Mich.

William F. V. Neumann, (Electrical). Lineman Elect. Rd. Do. Chase Constr. Co., Detroit. Romeo, Mich.

George C. Pratt, (Electrical). Supt. Barrington Elect. Light Co., '97-8. Audit. Dept. West. Elec. Co., '98-9. M'g'r. do. '99 to date. Chicago, Ill.

Joseph Perrien, B.S. (Mich. Agr. Coll.) (Mechanical). Detroit, Mich.

William H. Rippey, (Civil). Recorder U. S. Survey, Birmingham Canal, '97. Asst. Engr. Birmingham Traction Co., '98. Dftsman Keystone Bdge. Wks. Pittsburg, Pa.

Frederic C. Roberts, B.S.,(Earlham). (Civil). W. Elkton, O.

Francis J. Seabolt, (Mechanical). With Stephenson Mnfg. Co. Marinette, Wis.

Charles G. Simonds, (Mechanical). Morton Mfg. Co., Muskegon, '97. Shaw Electric Crane Co. Filer & Stowell Mfg. Co., '98. Dftsman T. L. Smith. Do. Milwaukee Bdge. Wks. Milwaukee, Wis.

Weston Small, (Civil). Amboy, Ind.

Emil G. Struckman, (Mechanical). Fairbanks, Morse & Co. Beloit, Wis.

ARTHUR C. TAGGE, (Electrical). Link Belt Co. Chicago, Ill.

MELVIN S. TREVIDICK, (Electrical). Chicago Ship Bldg. Co., '97 to date. Chicago, Ill.

ALEXANDER G. UNSOLD, (Mechanical). Dftsman Detroit Stove Wks., '97-8. Leveler for City Engr., '99 to date. Detroit, Mich.

FREDERICK E. VICKERS, (Electrical). Elect. Transmission. Utah, Provo.

THEODORE VLADEMIROFF, (Electrical). With Western Elect. Co. 2d Class Engr. U. S. S. Helena. Chicago, Ill.

CHARLES D. WEBSTER, (Mechanical). Business. Bay City, Mich.

ROY R. WILEY, (Electrical). E.E. (U. of Wis.). With Diamond Meter Co. Peoria, Ill.

IRVING C. WOODWARD, (Mechanical). Iron Mountain, Mich.

WALTER H. WOODS, (Electrical). U. S. Postal Clerk. Ann Arbor. Mich.

1898.

CHARLES W. BAGGOTT, (Civil). With U. S. Scale Co., '98. Terre Haute, Ind.

BANJAMIN F. BAILEY, (Electrical). With Edison Co., Detroit. Genl. Electric Co. Schenectady, N. Y.

FREDERIC C. BARR, (Electrical). Genl. Elect. Co. Schenectady, N. Y.

MURRAY BLANCHARD, (Civil). Recorder U. S. Deep Waterways Survey, '98. Sault Ste. Marie, Mich.

FREDERICK P. BEACH, (Electrical). Lexington, Mich.

FREDERICK H. BOOMHOWER, (Electrical). Constr. Engr. Waverly Lighting Co., '98-9. Elect. Engr. Auburn Prison, '99 to date. Auburn, N. Y.

FREDERICK C. BORST, (Mechanical). Mech. Dept. D. &. R. G. R. R., Denver, Colo.

THOMAS A. BRAGG, (Mechanical). Erect. Engr. New Era Iron Wks. Co. Dayton, O

IRVING J. BROWN, (Electrical). Dftsman Brown Hoist. & Mach. Co. Do. Kilby Mfg. Co. Cleveland, O.

ROY W. BROWN, (Electrical and Mechanical). Geneseo, Ill.

JOHN W. BYERS, (Electrical). Student Harvard Univ.,' 98-9. Cambridge, Mass.

EDWARD B. COOLIDGE, (Electrical). Student Mass. Inst. Tech., '98-9. Boston, Mass.

SOLLACE B. COOLIDGE, (Electrical). Agt. Beaumont & Chauncy Coal Co. Detroit, Mich.

Charles O. Cook, (Mechanical and Electrical). Dftsman Variety Iron Wks. '98. Do. Kilby Mfg. Co., Cleveland. Mich. Telephone Co. Detroit, Mich.

Leonard P. Coulter, (Electrical). Meter Insp., Diamond Meter Co. Peoria, Ill.

John S. Cowgill, (Electrical). With West. Elect. Co. Chicago, Ill.

Faust F. Crampton, (Electrical). Asst. Exam. Patent Office. Washington, D. C.

Henry W. Daniels, (Civil). Teaching. Onsted, Mich.

Isaac De Young, (Civil). C. C. C. & St. L. Ry., '98. Insp. Mich. Lake Superior Power Co. Sault Ste. Marie, Mich.

Amos F. Everett, (Civil). U. S. Deep Waterways Survey, '98. Lansing, Mich.

Howard Felver, (Mechanical). Instr. Math. Marinette, Wis.

Robert M. Fox, (Civil). U. S. Deep Waterways Survey, '98.

Frank A. Fucik, (Mechanical). So. Chicago Ship-bldg. Co. Chicago, Ill.

Francis F. Gillen, (Civil). Recorder U. S. Deep Waterways Survey, '98. Insp. Mich. Lake Superior Power Co., '98. Engr. Asst. Dept. Bldgs. and Grounds. Washington, D. C.

Leon Goldsmith, (Electrical). With Chicago Edison Co. Chicago, Ill.

Ernest P. Goodrich, (Civil). Edison Illum. Co., Detroit, '98. Engr. Asst. Bldgs and Grounds, Washington. Civil Engr. U. S. Navy. Brooklyn, N. Y.

Fred M. Green, (Mechanical). Dftsman Detroit Heat. & Ventil. Co., '91–2. Do. Elect. Wks.; '93. Do. Frontier Iron Wks. Do. Russel Wheel & Fdry. Co., '95–6. Insp. Mich. Lake Superior Power Co., '98. Sault Ste. Marie, Mich.

Archie L. Harris, (Civil). Dftsman U. S. Deep Waterways Survey. Hudson, N. Y.

Harry E. Harrington, (Electrical). With West. Elect. Co., '98–9. Do. Telephone Co. Chicago, Ill.

Le Roy M. Harvey, (Electrical). Teleg. Dept. C. & N. W. Ry., '98. Testing Dept. Westinghouse Mfg. Co., '99. Pittsburg, Pa.

Percy M. Holdsworth, (Mechanical). Testing Dept. Fairbanks, Morse & Co. Motive Power Dept. Atl. Coast Line R. R. Wilmington, N. C.

Edward P. Marsh, (Mechanical). Car Inspector, C. & N. W. Ry., '98. Oak Park, Ill.

William J. Marsh, (Electrical). Pittsford, N. Y.

HOWARD B. MERRICK, (Civil). Masonry Insp. G. N. Ry. '98. Leveler do. '98. Asst. Engr. do., '98 to date. Cambridge, Minn.

HERBERT A. MOODY, (Mechanical). Dftsman Morton Mfg. Co. Muskegon, Mich.

FRED W. NEWELL, A.M. (Bates), (Electrical). With Elwell-Parker Elect. Co., '98 to date. Cleveland, O.

CLAUDE G. NEWTON, (Civil). U. S. Deep Waterways Survey, '98. Dftsman Genl. Elec. Co. Do. Milwaukee Bdge. Wks. Milwaukee.

JOSEPH H. PETTERSCH, (Mechanical). Dftsman Gates Iron Wks., '98. Do. Fraser & Chalmers, '98 to date. Chicago, Ill.

OTTO PRUESSMAN, (Electrical). With West. Elec. Co. Chicago, Ill.

EDWARD H. RAVENSCROFT, (Civil). With R. Modjeski, Cons. Engr. '98 to date. Chicago, Ill.

CLARENCE W. RAYNOR, (Civil). Dftsman and Asst. Engr. B. R. & P. Ry., '98 to date. Rochester, N. Y.

HERBERT L. RUSSELL, (Civil). Genl. Elect. Co. Schenectady, N. Y.

FRANK N. SAVAGE, (Civil). With Chicago Edison Co. Grad. Student U. of M., '98–9. Ann Arbor, Mich.

LLOYD B. SMITH, (Civil). U. S. Deep Waterways Survey. Dftsman Paige Iron Wks., Do. Mo. Valley Bdge. Wks. Leavenworth, Kan.

JOHN F. STREIB, (Civil). U. S. Deep Waterways Survey. Dftsman Genl. Electric Wks. Schenectady, N. Y.

JAMES T. ST. CLAIR, (Electrical). Grad. Student, U of M., '98–9. Ann Arbor, Mich.

CLARENCE W. SQUIER, (Electrical). Elect'n. G. W. Jones Elect. Co. Elwell-Parker Elect. Co. Dftsman E. H. Dyer & Co. Cleveland, O.

ROBERT STECK, (Electrical). With Chicago Edison Co. Do. C. A. Pratt, Cons. Engr. Do. Western Elect. Co. Chicago, Ill.

HOWARD P. TREADWAY, (Civil). Asst. Surveyor Old Dominion Copper Min. &. Smelt. Co. Globe. Arizona.

CLAUDIUS H. THOMAS, (Mechanical). Detroit, Mich.

SUTTON VAN PELT, (Civil). U. S. Deep Waterways Survey. Mich. Lake Superior Power Co. Sault Ste. Marie, Mich.

ALBERT A. WEBER, (Mechanical). Student in Medicine, U. of M. Ann Arbor, Mich.

MOREY A. WOOD, (Mechanical). Instr. Math. Burlington, Iowa.

FAY WOODMANSEE, (Electrical). Dftsman Genl. Elect. Co. Schenectady. N. Y.

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*C. O. AVEY, '78, died 1896.

*D. MCKENZIE, '65, died June, 1897.

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during the University year

UNIVERSITY OF MICHIGAN

DEPARTMENT OF ENGINEERING

GENERAL ANNOUNCEMENT

1901–1902

ANN ARBOR, MICH.
PUBLISHED BY THE UNIVERSITY
1900

UNIVERSITY OF MICHIGAN

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1901–1902

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1900

CALENDAR.

1901.

Feb. 11. Second Semester Begins.

April 12. (Evening.) Recess begins, ending April 22 (evening).

June 18. Class Day.

June 19. Alumni Day.

June 20. Commencement in all departments of the University.

June 21 to Sept. 23. Summer Vacation.

July 1 to Aug. 10. Summer School.

Sept. 19 to 21. *Examination for Admission to the Department of Engineering.*

Sept. 24. First Semester Begins in All Departments of the University.

Nov. — Thanksgiving Recess of three days, beginning Tuesday evening, in all Departments of the University.

Dec. 20. (Evening.) Holiday Vacation begins in all Departments.

1902.

Jan. 7. Exercises resumed.

Feb. 7. (Evening.) First Semester Closes.

Feb. 10. Second Semester Begins.

April 11. (Evening.) Recess begins, ending April 20 (evening).

June 19. Commencement in all Departments of the University.

Department of Engineering.

FACULTY.*

JAMES B. ANGELL, LL.D., PRESIDENT.

CHARLES E. GREENE, A.M., C.E., *Professor of Civil Engineering and Dean of the Department of Engineering.*

WILLIAM H. PETTEE, A.M., *Professor of Mineralogy, Economic Geology, and Mining Engineering.*

ISAAC N. DEMMON, LL.D., *Professor of English and Rhetoric.*

MORTIMER E. COOLEY, M.E., *Professor of Mechanical Engineering.*

WOOSTER W. BEMAN, A.M., *Professor of Mathematics.*

CHARLES S. DENISON, M.S., C.E., *Professor of Descriptive Geometry, Stereotomy and Drawing.*

HENRY S. CARHART, LL.D., *Professor of Physics, and Director of the Physical Laboratory.* (In charge of Electrical Engineering.)

RAYMOND C. DAVIS, A.M., *Librarian.*

OTIS C. JOHNSON, PH.C., A.M., *Professor of Applied Chemistry.*

PAUL C. FREER, PH.D., M.D., *Professor of General Chemistry, and Director of the Laboratory of General Chemistry.*

JOSEPH B. DAVIS, C.E., *Professor of Geodesy and Surveying.*

ASAPH HALL, JR., PH.D., *Professor of Astronomy, and Director of the Observatory.*

ISRAEL C. RUSSELL, C.E., LL.D., *Professor of Geology.*

EDWARD D. CAMPBELL, B.S., *Junior Professor of Analytical Chemistry.*

ALEXANDER ZIWET, C.E., *Junior Professor of Mathematics.*

GEORGE W. PATTERSON, JR., PH.D., *Junior Professor of Physics.*

JOHN O. REED, PH.D., *Junior Professor of Physics.*

HERBERT C. SADLER, B.S., *Junior Professor of Naval Architecture.*

PAUL R. DE PONT, A.B., B.S., *Assistant Professor of French, and Registrar of the Department of Engineering.*

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* In this list are included a few other officers and instructors with whom engineering students are likely to elect work.

JOSEPH L. MARKLEY, PH.D., *Assistant Professor of Mathematics.*

MAX WINKLER, PH.D., *Assistant Professor of German and temporarily in charge.*

JOHN R. ALLEN, M.E., *Assistant Professor of Mechanical Engineering.*

WILLIAM L. MIGGETT, B.S., *Superintendent of Shops.*

GEORGE O. HIGLEY, M.S., *Instructor in General Chemistry.*

DAVID M. LICHTY, M.S., *Instructor in General Chemistry.*

CLARENCE G. WRENTMORE, M.S., *Instructor in Descriptive Geometry and Drawing.*

KARL E. GUTHE, PH.D., *Instructor in Physics.*

ARTHUR G. HALL, B.S., *Instructor in Mathematics.*

JAMES W. GLOVER, PH.D., *Instructor in Mathematics.*

HERBERT J. GOULDING, B.S., *Instructor in Descriptive Geometry and Drawing.*

ALFRED H. WHITE, A.B., *Instructor in Chemical Technology.*

CARROLL D. JONES, E.E., *Instructor in Electrical Engineering.*

WILLIAM H. BUTTS, A.M., *Instructor in Mathematics.*

SHIRLEY W. SMITH, B.L., *Instructor in English.*

GEORGE L. GRIMES, B.S., *Instructor in Mechanical Engineering.*

CHRISTIAN F. GAUSS, A.M., *Instructor in French.*

EUGENE C. SULLIVAN, PH.D., *Instructor in Analytical Chemistry.*

HENRY C. ANDERSON, M.E., *Instructor in Mechanical Engineering.*

JOHN DIETERLE, A.B., *Instructor in German.*

ALICE L. HUNT, *Instructor in Drawing.*

GEORGE K. BURGESS, B.S., *Instructor in Physics.*

EDWARD B. ESCOTT, B.S., *Instructor in Mathematics.*

WILLIAM MARSHALL, M.S., *Instructor in Mathematics.*

FRED M. GREEN, B.S., *Instructor in Civil Engineering.*

WALTER B. FORD, A.M., *Instructor in Mathematics.*

ALFRED L. NEWTON, *Assistant to the Dean of the Department of Engineering.*

HARRY J. SPROAT, *Assistant in Astronomy.*

ALFRED L. DAVENPORT, *Assistant in Physics.*

Special Assistants in the Engineering Shops.

ROBERT A. WINSLOW, *Foundry.*

HARRY M. COBB, *Iron Room.*

HORACE T. PURFIELD, *Wood and Pattern Room.*

WILLIAM R. McDONALD, *Forge Shop.*

Department of Engineering.

General Information.

The University of Michigan is a part of the educational system of the State, and derives from the State, in one way or another, the greater part of its revenue. The University comprises the Department of Literature, Science, and the Arts, and six professional schools, each of which has its own Faculty and issues each year a separate departmental announcement. The various Faculties include more than one hundred and fifty officers of instruction, besides numerous assistants, some of whom participate in the work of teaching. Thirty-five hundred students, representing all the States and Territories, and many foreign countries, are in attendance.

In the legislative act under which the University was organized in 1837, provision was made for instruction in engineering. There are few older technical schools in the United States. Work was begun in this line in 1853, and the first degrees were conferred in 1860. The engineering courses were included in the Department of Literature, Science, and the Arts, until the close of the collegiate year 1894-95. At that time the Department of Engineering was established by the Board of Regents.

Persons who wish to become professional engineers are offered here thorough courses of study in civil, mechanical, electrical, and marine engineering, and naval architecture. The work extends through four years, and leads to the degree of Bachelor of Science. The degrees of M. S., C. E., M. E., and E. E. are given for postgraduate work. The aim of the department is to lay a foundation of sound theory, sufficiently broad and deep to enable its graduates to enter understandingly on the further investigation of the several specialties of the engineering profession; and at the same time to impart such a knowledge of the usual professional practice as shall make its students useful in any position to which they may be called. While the adaptation of theory to practice can be thoroughly learned only by experience, there are many matters in which the routine work of an engineering field party, office, or drafting room can be carried out on a greater or less scale in a training school. *The technical branches are under the direct care of those who have had professional experience as well as a full scientific training.* The instructors who have the several branches in charge aim to fit the students, as far as possible, for the requirements of active practice.

The academic year extends from the Tuesday preceding the last Wednesday in September to the Thursday preceding the last Wednesday in June. (September 24, 1901, to June 19, 1902).

REQUIREMENTS FOR ADMISSION TO THE DEPARTMENT OF ENGINEERING.

[For admission to advanced standing, see page 10.]

[For admission of students not candidates for a degree, see page 11.]

Candidates for admission must be at least sixteen years of age, and must present satisfactory evidence of good moral character. They must bring credentials from their last instructor, or from the last institution with which they have been connected.

Unless admitted on diploma from an approved school (see page 13), any student who desires to become a candidate for a degree must pass examinations in the subjects described below. Before entering upon the examination each applicant must present his credentials to the Dean of the Department at his office in the Engineering Building.

Certificates and diplomas from schools other than those officially examined and approved by the University, as specified on page 13, will not excuse applicants from admission examinations.

Students who have satisfied the requirements for admission to the Department of Literature, Science, and the Arts are admitted to this department, but must make up their deficiencies in plane trigonometry and science, if such deficiencies exist.

ADMISSION OF CANDIDATES FOR A DEGREE.

The subjects on which applicants for admission to any of the courses leading to a degree in engineering will be examined are as follows: —

English Language.— *Grammar.*— Selections for analysis and parsing will be set, arranged to test the applicant's knowledge of the leading facts of English Grammar. To meet this requirement, a review of the subject should be had during the last year of the preparatory course.

Composition and Rhetoric.— The purpose of the examination in composition is to test the applicant's ability to write good English. To this end he will be asked to write two essays of not less than two hundred words each, one upon a subject drawn from the books mentioned below, and the other upon a subject drawn from his experience or observation. The language of these essays must be grammatical and clear. The spelling, punctuation, and capitalizing must be correct. The applicant must show ability to discriminate in the use of words, and to construct well organized sentences and paragraphs. A topical outline should accompany each essay.

The titles of the books from which subjects for compositions will be chosen in the years named, are here given. The applicant should make himself familiar with the plot, incidents, and characters of each work. Equivalents will be accepted.

As preparation for this requirement, sustained and regular practice in writing is earnestly recommended. The student should prepare numerous written exercises throughout the four years of the high school course, and a sufficient number of these exercises should be corrected by the teacher and revised by the student to secure the desired accuracy. The subjects upon which the student writes should not be drawn exclusively from literature; a considerable proportion of them should be taken from the student's every-day experience; and topics should be so distributed as to give proper training in the various types of discourse, namely, description, narrative, argument, and exposition. The student should be grounded in the essentials of rhetoric, but those principles should receive emphasis which are most likely to be of service to him in his practice in writing, such as the principles of sentential structure, paragraphing, and the outlining of the essay. The correction of stock specimens of bad English is not recommended, and will form no part of the entrance requirement.

It is further recommended that the reading of English classics and the memorizing of notable passages, both in prose and poetry, should form a regular exercise throughout the whole preparatory period. This is all-important for the development of a correct taste in language and literature.

1900. Chaucer's *The Knight's Tale,* or Dryden's *Palamon and Arcite;* Milton's *Paradise Lost,* Books I and II; Pope's *Iliad,* Books I, VI, XXII, and XXIV; The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* De Quincey's *Revolt of the Tartars;* Cooper's *The Last of the Mohicans;* Macaulay's *Essay on Milton;* Burke's *Conciliation with the Colonies.*

1901 and 1902. Shakespeare's *Merchant of Venice* and *Macbeth;* Milton's *Lycidas, Comus, L'Allegro, and Il Penseroso;* Burke's *Conciliation with the Colonies;* Macaulay's *Essays on Milton and Addison;* Pope's *Iliad,* Books I, VI, XXII, and XXIV; The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Coleridge's *The Ancient Mariner;* Scott's *Ivanhoe;* Cooper's *The Last of the Mohicans;* Tennyson's *The Princess;* Lowell's *The Vision of Sir Launfal;* George Eliot's *Silas Marner.*

1903, 1904, and 1905. Shakespeare's *Merchant of Venice, Julius Caesar,* and *Macbeth;* Milton's *Lycidas, Comus, L'Allegro, and Il Penseroso;* Burke's *Conciliation with the Colonies;* Macaulay's *Essays on Milton and Addison;* The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Coleridge's *The Ancient Mariner;* Scott's *Ivanhoe;* Carlyle's *Essay on Burns;* Tennyson's *The Princess;* Lowell's *The Vision of Sir Launfal;* George Eliot's *Silas Marner.*

English Literary History.— In addition to the books just named, it is expected that several other English Classics will be read each year. These readings should be connected, in reasonable measure, with the lives and characters of the authors read and with the history of their times. A good knowledge of the chronological order and of the leading characteristics of the leading modern English writers should be aimed at. Care should be taken not to overload the text of these classics with a mass of irrelevant and petty learning. Many of the "school classics" now in use are over-edited.

English Literature.— The requirement is intended to cover one year's work. Stopford A. Brooke's English Literature (edition of 1896), or any other manual, may be used for an outline of the subject. As much time as practicable should be given to the careful reading of representative authors in each period.

Mathematics.* — *Algebra.*— Fundamental Rules, Fractions, Simple Equations, Involution and Evolution, the Calculus of Radicals, and Quadratic Equations, as given in Olney's Complete School Algebra, or an equivalent in other authors.

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* Students entering at the beginning of the second semester (February 11, 1901), should be prepared in the mathematics of the first semester in addition to the other requirements for admission.

Geometry.— Plane, Solid, and Spherical Geometry as given in Beman and Smith's Plane and Solid Geometry, or an equivalent in other authors.

Trigonometry.— Plane Trigonometry as given in Olney's Elements of Trigonometry, or an equivalent in other authors.

N. B.—It is very desirable that High Schools whose graduates are received on diploma arrange their courses so as to include a portion of both Algebra and Geometry in their last preparatory year. Students who do not come from diploma schools should take a similar review if they expect to succeed in the study of mathematics in the University.

French, German, or Latin.— Applicants may offer French, German, or Latin, one of these three languages being required. It is expected that at least two years will be given to preparation in the language offered. The requirements in each are as follows: —

French.— The whole subject of French Grammar. The applicant will be expected to read at sight easy French, and to translate correctly into French simple English sentences. The first year ought to be spent chiefly on the grammar and easy reading; and the second devoted to reading good modern French, accompanied by grammatical analysis and exercises in writing. The texts read should be chiefly narrative and conversational prose; modern, rather than classic, dramas, should be read.

German.— (1) Ability to pronounce German correctly and to take part with reasonable correctness and facility in a simple conversation upon some topic drawn from the applicant's preparatory work. (2) Thorough familiarity with the everyday facts of the grammar, to be evinced by putting illustrative English phrases into German. (3) Ability to translate at sight a passage of fairly easy prose.

Advanced credit may be secured for one or two years of German or French study in excess of the two years required for admission; and also if Latin and German or Latin and French are offered, advanced credit is given for the modern language.

Latin.— Jones's First Latin Book, or an equivalent amount in any other introductory text-book, four books of Caesar's Gallic War, and one of the orations of Cicero.

Physics. — An amount represented by Carhart and Chute's Elements of Physics. Laboratory work in Physics is earnestly advised, though not required; but students who have completed a course in laboratory practice may expect to derive advantage from it if they take work in the physical laboratory in the University (see page

35). It is expected that a full year will be given to preparation in physics.

Chemistry.— The requirement is intended to cover one year's work. As a text-book, Freer's Elementary Chemistry, or an equivalent amount of work in Remsen's Introduction to the Study of Chemistry, is recommended. In either case the text should be accompanied by laboratory work.

History. — One year's work in General History as presented in such a work as Myers's General History, and one year's work in United States History and Civil Government. Johnston's History of the United States, McLaughlin's History of the American Nation, and Fiske's Civil Government, or Hinsdale's American Government are recommended as text-books.

Botany, Physical Geography, or Astronomy.— The applicant may offer any *one* of these subjects. The requirements, intended to cover a half-year's work in each subject, are as follows: —

Botany.— Laboratory work for half a year with occasional recitations and review exercises. The method followed in Spalding's Introduction to Botany, or other modern text-book of similar plan and scope, may serve to indicate the kind of work desired.

Physical Geography.— Tarr's Elementary Physical Geography, especially Chapters 9 to 21 inclusive, or an equivalent.

Astronomy.— Newcomb and Holden's Astronomy, Briefer Course, Young's Elements of Astronomy, or an equivalent. A knowledge of the principal constellations is required.

ADMISSION TO ADVANCED STANDING.

1. Graduates of the Department of Literature, Science, and the Arts of this University, or of any other reputable college, are admitted without examination to advanced standing as candidates for a degree in engineering, and are excused from a considerable portion of the general requirements (see page 50). The remaining requirements can be completed in two years, if the student takes as electives, while an undergraduate, the mathematics required of engineering students (see page 34) and Courses 1, 4, and 5 in drawing (see page 38). A knowledge of differential and integral calculus, of analytical mechanics, of elementary drawing, and of descriptive geometry, is needful for the advanced work.

2. Students who have completed at least one year's college work in an approved college, and who bring explicit and offi-

cial certificates describing their course of study and scholarship, and testifying to their good character, are admitted to advanced standing without examination, except such as may be necessary to determine what credit they are to receive for work done in the college from which they have come.

3. Students who have not completed a year's college work in an approved college, but previously to entering this department of the University have pursued studies beyond those required for admission, may be admitted to advanced standing on passing the regular entrance examinations, and examinations in such undergraduate studies as they may ask to be credited with in advance.

4. Rules Relating to Admission to Advanced Standing.

a. Any student, whether a candidate for a degree or not, who applies for advanced standing on the conditions stated in paragraphs (2) and (3) above, must present to the Dean a statement showing the amount of work done in the subjects in which credit is asked.

b. The application for advanced standing should be made to the Dean upon entering the Department. The Dean will then furnish a blank form for presentation to the professors in charge of the several subjects named in the blank.

c. Credits must be secured before November 1 or (if the student be matriculated at the beginning of the second semester) before March 15.

d. No credit will be given for advanced standing after the dates named in (*c*).

e. An account once closed can not be reopened without special permission of the Faculty.

ADMISSION OF STUDENTS NOT CANDIDATES FOR A DEGREE.

Persons who desire to pursue studies in this department, and do not desire to become candidates for a degree, are admitted on the following conditions:

1. All persons under twenty-one years of age must pass the regular entrance examinations.

2. Persons over twenty-one years of age must show that they have a good knowledge of English, and are otherwise prepared to pursue profitably the studies they may desire to

take up. Every applicant ought to have the training received in a good high school; and a knowledge of algebra, geometry, trigonometry, physics, and chemistry, equivalent, at least, to that prescribed in the requirements for admission, will be necessary.

3. Should a student who enters under the preceding provision (2) subsequently become a candidate for graduation, he must pass the regular entrance examination, at least one year previous to the time when he proposes to graduate.

4. Students not candidates for a degree who wish credit for studies pursued before admission are referred to the rules relating to advanced standing given above.

5. Students not candidates for a degree are expected to attend the lectures, recitations, and examinations in the branches prescribed for the regular students, and are required to take enough work to occupy them profitably.

The examination for admission to the Department of Engineering will be held on Thursday, Friday, and Saturday, September 19, 20, and 21, 1901. Applicants will not be examined at any other time except on payment of a special fee of *five dollars.*

As the examination begins at 8 A. M. on Thursday, it will be necessary for all applicants for admission on examination to present their credentials to the Dean of the Department, at his office, on Wednesday, September 18, between the hours of 9 and 5, and receive from him papers admitting to the examination.

The examinations in the several subjects will be in writing, and will be held in Tappan Hall in accordance with the schedule given below.

SCHEDULE OF EXAMINATIONS FOR ADMISSION IN 1901.

	THURSDAY.	FRIDAY.	SATURDAY.	
	Sept. 19.	Sept. 20.	Sept. 21.	TAPPAN HALL.
Physics	8 A. M.	......	......	Lecture Room
Geometry	......	8 A. M.	......	Lecture Room
Algebra	......	......	8 A. M.	Lecture Room
History & Civil Gov't.	10 A. M.	......	......	Lecture Room
Botany	......	10 A. M.	......	Lecture Room
Phys. Geog. & Astron.	......	4 P. M.	......	Lecture Room

English Literature	......	......	10 A. M.	Room 10
Latin	2 P. M.	2 P. M.	......	Lecture Room
German	2 P. M.	2 P. M	......	Room 10
French	......	2 P. M.	......	Room 12
English	......	......	2 P. M.	Lecture Room
Chemistry	4 P. M.	......	......	Lecture Room

ADMISSION ON DIPLOMA.

Students presenting graduation certificates from any of the schools officially approved by the Faculty of the Department of Literature, Science, and the Arts, signed by the superintendent or the principal of the school, are admitted without examination to the Department of Engineering. But if such certificate, though it might admit a student to the Department of Literature, Science, and the Arts, shows any deficiencies in the requirements for admission to the Department of Engineering, such deficiencies must be made up, or substitutions secured from the Dean; extra studies may be credited on advanced standing, if the subjects are taught in either of the two departments.

The certificate must state that the student has sustained his examinations in all the studies prescribed for admission to the Department of Engineering, or for the credits prescribed for admission to the Department of Literature, Science, and the Arts, and is recommended for admission to the University. It must be presented to the Dean of the Department within a year and three months after graduation from the school, and the student must then begin his work.

THE WORK OF THE DEPARTMENT.

The studies pursued in the earlier part of the course comprise, in *Mathematics,* advanced algebra, analytic geometry, and the elements of differential and integral calculus; in *French* and *German,* an amount covering in all about a year and a half of study; in *English,* courses in higher English grammar and composition; in *Physics* and *Chemistry,* studies of the principles; in *Drawing,* practice in geometrical and in mechanical drawing, and in the study of descriptive geometry; and in *Shop Practice,* carpentry, pattern-making and forging.

For the order of Studies see page 46.

The more technical subjects are taken up in the latter part of the course. Some of these subjects are of equal value to all classes of engineering students, such as analytical and applied mechanics, the strength and resistance of materials, and the metallurgy of the useful metals, especially iron and steel; others are adapted more particularly to the special wants of the students in the several courses. Their general scope may be seen from the following:

DESCRIPTION OF COURSES.

French and German.— A reading knowledge of these languages is aimed at, especially in scientific texts, in order that the students may be able to consult books in these tongues and to refer to scientific papers and reports of French and German engineers.

Physics.— The instruction in physics covers a thorough course with the use of trigonometry, and extends through an entire year. The first semester is devoted to mechanics, sound, and light; the second to heat, electricity, and magnetism. The subjects are amply illustrated with appropriate experiments accompanying the lectures. An additional short course in the laboratory introduces the student to quantitative methods in the study of physics, and prepares him for the more difficult and exacting work in electrical measurements.

Mathematics.—The required work (including theoretical mechanics) is the same for all students of engineering, and extends through the first five semesters. Advanced algebra and plane and solid analytic geometry are followed by the elements of the differential and integral calculus. Finally, analytical mechanics and the calculus, including the elements of differential equations, are carried on in close connection. In all these courses much time is devoted to the solution of problems in order to supplement a fair knowledge of the elementary principles of higher mathematics with the necessary facility in applying these principles to concrete cases.

Students desiring to pursue their mathematical studies further will find a large list of electives among the courses in mathematics and mechanics offered in the Department of Literature, Science, and the Arts.

Chemistry.—The course in the principles of chemistry, for all students of engineering, consists of lectures, with demonstrations and recitations. It covers briefly the facts regarding the metallic and non-metallic elements, and some attention is given to the method of scientific reasoning. Recent work in electro-chemistry is also touched upon. The students are prepared in this course to take up later the chemical processes involved in metallurgy.

Drawing.—A very complete course in mechanical drawing is given, embracing plane projection drawing, isometric drawing, descriptive geometry, and the elementary principles of coloring and shading, with original problems executed in the drawing room. Examples from numerical data are always given when suited to the conditions of the problem in hand. Students in mechanical engineering are required to sketch pieces of machinery, and afterwards to make working drawings suitable for use in the shop. The plans of surveys, plane-table work, maps, designs in engineering construction, and the thesis drawings naturally come under this head. Instruction is also given in free-hand drawing, topographical drawing, ornamentation and lettering, shades and shadows, linear perspective, and drawing for stone cutting. The work in drawing occupies the student a part of almost every day throughout the course.

There are five large and well-lighted drawing-rooms, three of which are in the engineering building and two in the engineering laboratory. There are also special rooms for blue-printing and a dark room for photography.

Mechanical Practice and Shop Work.—The aim of the instruction in this department is to make the student, as far as time will permit, acquainted with the best mechanical practice; the instructors in all practical work are men of wide experience, selected for their mechanical skill; and the department attempts to keep in touch with the most improved methods of mechanical construction.

The courses of instruction all begin with a systematic series of graded exercises, to give the student familiarity with the common tools used in the particular branch of work he is pursuing; and in connection with each course the theory of the process is taught by lectures or by assigned reading. The student thus becomes fitted to execute an ordinary piece of mechanical work and at the same time acquires familiarity with sources of information bearing upon such work. At a later stage in the course the student is taught to apply the principles previously studied in the class room, and to combine skill and knowledge in the transformation of crude materials into articles which have a market value.

In *Wood Work and Pattern Making,* after the student has completed the preliminary series of graded exercises, he is set to making and assembling the parts of some complete piece of carpenter or joiner work, and he then devotes the remainder of the time, about three-fifths of the whole, to the pattern work. Special stress is laid upon this part of the course. The student shapes, forms, and builds up patterns for castings in iron, brass, etc.; allows for shrinkage; makes core boxes; and becomes as familiar as possible, in the time allowed, with all the details of practice. Each class, with the help of the instructors, is expected to make a full set of the patterns needed for the construction of some special piece of working machinery.

In the *Foundry* the student learns to mould in green sand, in dry sand, and in loam, both for brass and for iron castings. Instruction is given in the making of cores for various purposes, and their use in the moulds; and in the art of selecting and mixing metals so as to produce the kind of material desired, careful attention being paid to the making of composition metals for specific purposes. Each student is required to take part in all of the work about the cupola and the brass furnaces, and to assume his share of their management during the periods of melting and casting.

In the *Forge Shop* the student is required to make forgings from a large variety of irons and steels. In this way he becomes familiar with different kinds and qualities of materials suited for forge work; he learns how to heat, forge, anneal, harden, and temper such tools as are used in machine shops; and he also has practice in soldering and brazing. The object of the course is to enable the student to acquire a certain degree of skill in practice, and at the same time impart to him a knowledge of the principles governing such processes of forging as an engineer is likely to be called upon to direct.

In the *Machine Shop* the instruction is conducted on the same plan as in the pattern shop. On the completion of the series of graded exercises, the student begins the construction of parts of machines. Each class undertakes the building of one or more simple machines, or pieces of apparatus; and the work is planned in such a way as to give opportunity for learning general shop manipulation. Advanced students are also allowed to elect extra work and to assist the skilled workmen in the construction of larger machines.

A description of the engineering shops is given on page 27.

Manual Training.— In all the above-described courses advanced work can be taken by students who wish to become specially skilled in certain lines, or who desire to fit themselves for instructors in Manual Training Schools or in shops of that character.

Surveying. (*a*) *For Students in Civil Engineering.*— The course covers a full academic year and includes text-book work, lectures, recitations, and field practice. The methods of surveying and computing used in laying out work are explained in detail; each student is required to make plats, maps, and the necessary calculations from actual surveys; and instruction is given in the proper care, use, and adjustments of instruments. There is an ample and varied supply of instruments for the use of students.

The class room instruction embraces the following topics: instruments and their adjustments; surveys for the enclosure and division of land; some account of the United States Land Survey; city surveys and town plats; surveys of lines of communication, such as roads, railways, and canals; hydrography; special surveys for various purposes of construction, such as laying out buildings, culverts, and abutments, and locating bridge piers; and, in general, the elements of all the ordinary operations to be expected in the professional practice of a civil engineer, but without including Land Surveying in the broad sense of the term. The principal text-books used are Johnson's Surveying, Raymond's Surveying, and Searle's Field Engineering. The more important works of reference are also easily accessible to the student.

The practical work outlined below, and carried on in the fall, early winter, and spring of each year, is intended to cover the elementary operations required in making surveys for engineering works, such as roads, streets, railways, canals, enclosures of land, public improvements, and the laying out of structures on the ground.

The steel-tape practice includes linear measurements, ranging lines, measuring and laying-out angles, laying-out circular curves, and making the records and computations pertaining to such work. With the transit and steel tape the student has practice in reading angles; traverse surveying; laying-out circular curves, simple and compound; and running straight lines. He is also required to keep the records and make the calculations connected with such work; to make plats, and to compute areas. The practical work with the level and rod includes simple levelling, check levels, and profile levelling, together with the necessary field notes and checks. The practice in topography embraces the use of the transit and stadia; plane-table work; and surveying with aid of the camera, including the development of negatives and the printing and mounting of photographs. From the field notes and photographs maps are made by the student. In this connection, also, the student has practice in making blue prints from negatives and from drawings.

During the last month of the academic year the class is in camp as a field party. A survey is made for some line of communication, usually a railroad, including exploration, preliminary and located lines, easements to curves, profile levelling, check levels, profile making, cross-section data, cross-sectioning, transfer of line to plugs near grade points, witnessing, and, in general, the preparation of the line for construction up to the point of beginning excavation. In this connection good field and office records are required; profiles and maps are made; and the necessary computations, including those for earthwork quantities, are worked out.

In addition to the railroad survey, some other piece of field work is undertaken, the selection being made according to the fitness of the locality, the number and the previous experience of the members of the class, the time, and the weather, the purpose being to fix, by practical application, the principles learned from textbook, lectures, or previous experience. Within the past few years, work of the character indicated below has all been done, though not all in any one year: small triangulation surveys, in which there is considerable reading of angles; compass surveys; shore-line surveys; surveys for special purposes, like town sites, bridge sites, cemeteries, or particular areas of unusual shape; resurveys of the United States Land Survey, including the finding and restoring of lost corners, and the subdivision of sections; contouring; hydrography; gauging of streams; levelling for special purposes, such as mill powers, lake levels, and the determination of the fall of streams; and, in general, any ordinary piece of field work, for which the locality chosen for the camp may afford favorable conditions.

The work in camp also includes office work along the various lines of field work, such as the computation of triangulations; reduction of careful measurements; calculation of earthwork, azimuth, areas, and elevations; mapping; platting; and profile-making.

(*b*) *For Students in Mechanical and Chemical Engineering.*—The student in mechanical engineering takes a short course in the use of instruments, which is nearly all practice. He is required to read angles with a transit; to make a traverse; to make steel-tape measurements; to do simple levelling; and to compute and plat an enclosure survey. The aim of the course is to cover the simple manipulations in the ordinary use of surveying instruments, and to qualify the student for such duties in this line as are apt to fall to the mechanical engineer, such as mapping an enclosure, staking out a building and fixing the levels for it, laying out foundations for machines or boilers and establishing the levels for them, lining up shafts, setting water power machinery, and preparing lines for transmission of power by wire-rope, compressed air, or water.

(*c*) *Other Courses.*— Courses in Land Surveying, the United States Land Survey, the Canadian Survey, and in other specialties are provided, if properly qualified persons present themselves in sufficient number to form classes.

Geodesy. — For students prepared to undertake the work a course is offered, comprising lectures, reference reading, and written class reports, on geodetic methods in the field with special reference to successful present day practice. Some consideration is given to notable historical surveys, and constant use is made of reports and standard works of reference.

Highway Construction.— A course of lectures, and text-book work, is given to students of civil engineering, on the construction and maintenance of roads, streets, pavements, and walks. References are made to existing examples and present practice. Byrne's Highway Construction is used as a text-book.

Municipal Engineering. — A course of lectures. prescribed reading, and recitations covers the special field of city engineering, points out its connection with, and dependence upon, other branches of engineering work, and shows how to apply the principles of engineering to the modern problems arising in the building and improving of cities. Among the topics treated are streets and their present uses, sewers, waterworks, public franchises, assessments, bridges, building inspection, fires, lighting, street cleaning, and garbage disposal. The instruction is not intended to be of a technical character, but it aims to set forth the principles that should guide the city engineer in his relations to various matters of public concern, and to supplement and apply to this special field the instruction given in other courses. This course should not be taken by undergraduates before their last year of residence.

Strength and Resistance of Materials. — A course of recitations and lectures continuing through the first half-year is devoted to this subject, and is attended by all the engineering students except those pursuing the chemical engineering course. Simple and restrained beams and girders, shafts, pieces under tension, columns and struts are analyzed for different conditions of load; riveted work is computed; the action of the different materials under applied forces, the distribution of stress, and the proper proportions to be given to the different parts and details of structures in order that they may safely fulfil their several functions, are carefully studied. Greene's Structural Mechanics is used as a text-book.

Tests of wood, iron, steel, cement, and other building materials are made in the Engineering Laboratory.

Theory of Structures. — Roof and bridge trusses, in wood and iron; arches, in wood, iron, and stone; trestles; brick and stone masonry; foundations; tunnels; and, in general, the whole theory of structures are discussed. In this course Rankine's Civil Engineering is used as a text-book, supplemented by full explanations, additional notes, lectures, examples, and problems, and illustrated by models, photographs, working drawings, and blue-prints.

Graphics. — A course of instruction extending through a year is given in the graphical analysis of roof and bridge trusses and arches under steady load, wind pressure and moving loads. The student is made familiar with both the analytical and graphical methods of treatment and thus possesses ready proof of the accuracy of his calculations. Greene's Roof Trusses, Bridge Trusses, and Arches are used as text-books.

Hydraulics. — The laws of the flow of water through orifices and pipes and over weirs; the gauging of streams and rivers; the designing of works for water supply, drainage, and sewerage; the laying out of canals; and the subject of river and harbor improvements are treated in this course. The text-book used is Merriman's Hydraulics.

Machinery, Prime Movers, and Power Transmission. — A course of instruction is given in mechanism, or the general principles of machinery, involving the study of gearing, screws, cranks, and levers, and the dynamics of machinery. In the study of prime movers, special attention is given to turbine and other water motors, and to steam engines. In the theory of machine construction, problems involving the strength and design of machines, and the materials used in their construction, and also involving the application of the principles of electricity, are studied at length in connection with such examples as illustrate the best practice. The instruction in power transmission covers the distribution of power by shafts, belts, rope, hydraulic and pneumatic transmission, and the arrangement of shafting and machinery in manufacturing establishments. Practical problems involving the strength of shafting, belting, and gearing are fully treated. Tests are made to determine the efficiency of machines, and the value of lubricants.

Design of Shop Machinery. — The student is taught to design one or more of the standard machines used in shops. He is shown how to combine his theoretical and his practical knowledge so as to conform to the best mechanical practice. He designs one or more complete machines, and makes a detailed drawing of each part for shop use. The drawings that possess merit and are carefully worked out are subsequently used in the shops. Instruction is also given in blue-print work. The course is intended in every respect to represent, as far as possible, the operations of actual business.

Designs in Engineering and Machine Construction. — Contemporaneously with the study of theory students are required to work out problems in design. They are furnished with the usual data for a design, and the kind or type of structure or machine is indicated. They are then expected to make the necessary calculations, paying particular attention to proportioning the different parts so as to secure strength, simplicity, and effect, and to present at a specified date complete working drawings, giving full details, accompanied by bills of materials, estimates, and specifications.

Metallurgy. — A course of instruction by lectures and recitations is given upon the subjects of fuel, refractory material, iron, and steel. The lectures are illustrated by charts and drawings of furnaces and appliances used and by samples of furnace products.

Thermodynamics.— This course embraces the study of the principles governing the action of heat engines in general, hot-air and gas engines, air compressors, compressed-air engines, and refrigerating apparatus.

Steam Engineering.—The work in this branch covers the practical use of steam. Furnaces and boilers are studied with reference to proper combustion of fuel; to securing maximum evaporative efficiency; and to proportioning the parts for strength, durability, and accessibility for cleaning and repairs. The care and management of engines and boilers, both in use and out of use, are fully considered. A study is made of the principal steam pumps and pumping engines. Tests are made to determine the value of fuels, quality of steam, and the efficiency of furnaces, boilers, and engines.

Gas Engines, Compressed Air, and Refrigeration.— The theory is discussed under thermodynamics. Additional courses are given, covering the application of the theory, mechanical details of construction, and methods of operation.

Heating and Ventilation.— A course of lectures and recitations is given covering the theory of heat as applied in heating, the design and construction of hot air, direct and indirect steam, hot water, and fan systems of heating. Plans are made for different systems and plants inspected.

Primary and Storage Batteries. — A brief course combines theory and experimental work in measuring electromotive forces, polarization, internal resistance, and efficiency. Several types of storage cells are in constant use.

Electrical Measurements. — This course extends through an entire year, and is devoted to practical work in the laboratory with the most modern apparatus. In addition to exact methods of measuring resistances, electromotive forces, and currents, it includes the calibration of the measuring instruments employed, the determination of capacity in absolute measure, the measurement of inductances, and the determination of the hysteresis curves of iron and steel.

Dynamo Electric Machinery. — The time given to this course is about equally divided between the study of the theory of generators and motors, and the determination in the electrical engineering laboratory of characteristic curves, of the series turns required to compound for constant potential, and of the efficiency of generators and motors.

Alternating Current Machinery. — To the theoretical study of this subject is added laboratory work with alternators, transformers, and two-phase or three-phase transmission.

Design of Electrical Machinery. — The course in electrical design gives the fundamental principles and illustrates them by numerical calculations of electromagnets, of direct current machines, motors, alternators, and transformers. The lecture course is supplemented by exercises in drawing in which each student makes working drawings to accompany his own designs. Highly satisfactory transformers, two-phase and three-phase generators, and induction motors have been built by electrical engineering students in the engineering shops.

Industrial Chemistry. — Under this head come those courses which treat of chemical processes on a manufacturing scale. The chief subjects are: Fuels; water; the acid, alkali, cement, and glass industries; by-products from coal and wood; starch, glucose, and sugar; fermentation and distillation; fats, oils, and soaps; bleaching and dyeing; tanning; the paper manufacture, etc.

Chemical Engineering. — This course is designed to meet the demands of manufacturers for men capable of intelligently directing manufacturing processes and handling machinery. To this end sufficient chemistry is introduced into the course to enable the graduate to act as his own chemist on most occasions. The instruction includes thorough laboratory drill in qualitative and quantitative analysis, courses in organic chemistry, chemical technology, metallurgy, and a special laboratory course in connection with some chosen manufacturing industry.

The engineering studies are, in the main, those required for the course in mechanical engineering; the student gains a knowledge of the construction and use of machinery, and has practical drill in the drawing rooms and shops; but the chemical studies indicated above take the place of the advanced mathematics and the higher work in engineering design.

By a proper selection of elective studies, and an additional year of college work, the graduate in chemical engineering can also secure the degree of Bachelor of Science in mechanical engineering.

Ship Calculations.— Introductory; methods of laying off, and various lines used in fairing a vessel.

Rules for determining plane areas bounded by curves, with proofs of same; application to ship work; determination of volume of displacement, centres of buoyancy and metacentres; use of planimeter and integrator; methods of plotting results of calculations; standardizing results; change of trim due to moving weights on board; change of trim due to flooding a compartment; determination of size of compartment that can be flooded with safety at any part of the vessel; experimental determination of centre of gravity; calculation of capacity of holds, bunkers, etc., and the effect on stability and trim due to cargoes of varying density; rules for tonnage and freeboard; launching calculations; steering and action of rudder.

Strength of Ships. — Application of curves of shearing forces and bending moments to ships; determination of curves of buoyancy, weight, shearing forces and bending moments for ships floating in still water, and in waves, upright and inclined; effect of taking into account wave pressures; tensile, compressive and shearing stresses in vessels; local stresses due to discontinuity of structure; stresses due to docking; transverse strength; effect of pitching and heaving; strength of riveted joints and relation of pitch and diameter of rivets and thickness of plate; general discussion of types of vessels; classification societies' rules.

Stability of Ships.—Various kinds of equilibrium; initial stability; investigation of formulas for stability; stability curves; influence of type of vessel, freeboard, etc., on stability; cross curves of stability and methods of determining same; effect of free water in the hold; stability in a damaged condition; dynamical stability; effect of wind pressure; surfaces of buoyancy and flotation considered geometrically; rolling of ships, resisted and unresisted, in still water and in waves; methods of reducing rolling.

Resistance and Propulsion of Ships.— Early theories; wave making, eddy making, and surface friction resistance; stream line theory; Froude's experiments; experiments with models; law of comparison of ship and model; effect of form and length upon resistance; progressive trial trips and data obtained; ratio of E. H. P. to I. H. P.; coefficients of performance; results of trial trips applied to determination of I. H. P. for a new vessel; waves created by ships;

trochoidal theory of waves; propulsion by sails; centre of effort; wind pressure; power to carry sail; efficiency of propellers, jet, paddle, and screw; determination of size of propeller for a given ship; law of comparison of propellers.

Design of Ships.— General discussion of dimensions and form; effect of variation of dimensions on strength, stability, etc.; determination of dimensions to secure a certain speed, cargo capacity, etc.; method of obtaining the lines of a vessel; estimates and calculations of weights of hull and machinery; general arrangements of various types; structural arrangements; determination of I. H. P.

Practical Shipbuilding.— Arrangements of ship-yards; methods and sequence of work; preparation of working plans, including all structural details; ordering material from plans; pumping, piping, and ventilation plans; specifications and estimates. Visits to ship-yards will be arranged, and the students will report upon the same.

Marine Engineering.— Discussion of types of engines and boilers; determination of sizes for a given set of conditions; ratio of cylinders; stroke and piston speed; weight and space occupied; mechanical details of construction; arrangement of boilers; forced and natural draught and their effect upon design; vibrations and methods of balancing engines; auxiliary machinery.

Drawing and Design.—The above courses are accompanied by work in the drawing room, which will include: Laying off and fairing a set of lines from given offsets; calculations of displacement, centres of buoyancy, etc., and plotting results; construction of capacity curves; calculation of change of trim and curves connected therewith; of launching; of strength and determination of curves of weight, buoyancy, shearing forces and bending moments; calculation of stresses; of curves of stability.

Later, the student will work out a design for a vessel to fulfil given conditions, as, for instance, a fast passenger or cargo steamer, cruiser, battleship, torpedo boat, or steam yacht, and will prepare the lines, general arrangement, midship section, and all calculations connected with the above, and if time permit, a complete set of working plans together with an order form and specification.

In marine engine drawing the student will design a marine boiler with all details, and also a marine engine with as many of the detail plans as possible, and will make all necessary calculations.

Visits of Inspection.—As often as practicable, visits are paid to neighboring manufacturing establishments, to electric light and electric power stations, and to points of engineering interest, for the purpose of acquiring a knowledge of the methods employed in building, in the construction of bridges, machinery, and ships, and the best practice in electrical manufacturing and engineering on a large scale.

Examinations.

Examinations, usually in writing, are held at the end of each semester, but the classes are liable to be examined at any time, without notice, on any portion of their previous work.

FACILITIES FOR INSTRUCTION.

The collections for illustrating the instruction given comprise models, drawings, photographs, lithographs, and blue prints representing trusses, arches, and details of construction in iron, wood, and stone; sections of valves, pumps, and injectors; indicators and gauges; working models in various lines and full sized machines; working drawings of bridges; engines, dynamos, etc. These collections are receiving additions from year to year, by gift and purchase, and are invaluable to the student.

Tests of engines and boilers, and of machinery in general, will be made on request, and the profit of such work devoted to extending the facilities of the engineering laboratory. The data of all experiments and tests made are kept in the laboratory records. Tests of materials are also conducted for private parties, and reported upon when desired.

All the laboratory work is on a practical basis, and is done as nearly as possible as it would be done in any well arranged manufacturing establishment. There is a metallurgical laboratory connected with the chemical laboratory, supplied with assay furnaces and other appliances. The latest and best books on professional subjects are added yearly to the library, where they are accessible to all; and frequent references are made to them in the class room as the various subjects are brought forward.

Physical Laboratory.

The basement of the physical laboratory is devoted entirely to experimental work in electricity and magnetism. All of this work is open to students in physics.

On the first floor are a commodious lecture room, an apparatus room, a general laboratory for elementary work, a balance room, a mercury room, and two rooms for a private laboratory.

The laboratory is supplied with the most modern apparatus from the best American and European makers. In sound, it includes tuning forks and resonators from Koenig of Paris; in light, a spectrometer with 12-inch divided circle, an ophthalmo-spectroscope from the Geneva Society, an optical bench, with accessories, from

Duboscq, a Zeiss focometer, spectrometer, and interferometer, and a polarimeter from Schmidt and Haensch.

The work in the laboratory is entirely quantitative in character, but provision has been made for illustrating the general principles and laws of physics in the lecture courses.

Chemical Laboratories.

The chemical laboratories provide for classes in general, analytical, organic, and physical chemistry, in pharmacy, in chemical technology, and in metallurgical assaying. They also provide for original research in the several branches of chemical science and for independent investigations in technology. In the course of the year, classes are formed in forty-six distinct courses of study. In the greater number of these courses the method of work combines training in laboratory operations with instruction by lectures and conference, these methods being united in one course.

The chemical building contains in all about 37,000 square feet of floor space. Besides the rooms for recitations, storage, administration, etc., the laboratories for students have an area of about 25,000 square feet.

The laboratory of general chemistry is separately organized. Courses in elementary inorganic chemistry, as well as in physical chemistry and the advanced branches of the science are offered; research work both in inorganic and in organic general chemistry is also arranged for a limited number of students. Modern apparatus is on hand for all the varieties of work that are liable to be undertaken, and a well-equipped balance room is provided.

The laboratories of analytical chemistry, organic chemistry, pharmacy, and chemical technology, are carried on together. There are separate work rooms for qualitative analysis, quantitative analysis, iron and steel analysis, electrolytic work, pharmaceutical preparations, organic preparations, organic analysis, physiological chemistry, and assaying of ores,— as well as rooms for the weighing-balances and instruments of precision, for gas analysis, and for optical work. The rooms recently fitted up for chemical technology in various industrial branches have nearly 3,000 square feet of floor space. There are eleven separate rooms for original research, two lecture rooms, and two recitation rooms. In the ventilation of the work rooms the supply of fresh air is enforced by driving fans, and the removal of foul air is effected by draught flues and by electric-motor fans, with which, also, working hoods are connected.

The chemical laboratories are open throughout the college year to all students of the University, and are regularly used by the several departments. They are also open to any person who wishes to pursue special studies therein, provided he complies with the conditions for admission to that department of the University to which the desired special studies properly belong.

Over three hundred students are engaged in these laboratories at the same time, each at a table provided for one worker. During the year from 600 to 700 students complete from one to five courses of study each in the various branches of chemistry. The students engage in chemical work as it is needful for their different purposes, — the pursuit of science, or the preparation for teaching, for the several professions applying chemistry, and for the various chemical arts and industries.

Engineering Shops.

The engineering shops are in a group of connected buildings, containing about 17,000 square feet of floor space devoted to shop work.

The *Wood and Pattern Shop,* 40 by 80 feet, is equipped with the tools and machinery usually found in a first-class establishment. One end of the shop contains the work-benches and the tools needed for hand work; the other contains a good variety of wood-working machinery, much of which was built in the shops. Above the woodroom a pattern-loft, 40 by 80 feet, contains a large collection of patterns made by students during the past few years.

The *Foundry,* 30 by 80 feet, is equipped with two iron cupola furnaces, one capable of melting six hundred pounds, and the other two tons, of iron an hour; two brass furnaces of a capacity of 150 pounds each; a modern core-oven; elevator; crane; blowers; and a supply of flasks and small tools adapted to the work to be done. A large part of this equipment was made in the shops.

The *Forge Shop,* 30 by 40 feet, contains twelve forges and anvils, a drill press, an emery wheel, a punching and shearing machine, pressure and exhaust blowers, and many small tools.

The *Machine Shop,* 40 by 80 feet, contains lathes, planing machines, drill presses, milling machines, a shaper, grinding machines, and other tools for working in iron. Much of the machinery was made in the shop. The tool room is well supplied with small tools.

The *Drawing Room,* 32 by 54 feet, is supplied with blue-print apparatus, drawing desks, and other furniture needed for the use to which the room is put.

The central portion of the building, 32 by 54 feet, contains in the basement a well-ventilated wash-room, and on the first floor an engine room with a 10 by 30 Reynolds-Corliss engine, a storeroom, and an office for the superintendent. Here is also a room in which instruction is given, in the construction and maintenance of scientific laboratory apparatus, to students preparing to teach science.

New machinery is added to each shop from time to time for the accommodation of engineering students and others desiring instruction and practice in the use of tools for working in wood and metal. Opportunity is afforded to become familiar with the more common materials and forms of construction used in engineering structures, buildings, and machinery. In all work an effort is made to follow the practice of the best shops.

Engineering Laboratory.

The *Engineering Laboratory* is devoted to experimental work in connection with the testing of engines, boilers, pumps, indicators, belting, gearing, lubricants, and strength of materials, and to such original work as can be undertaken with advantage. The work also extends to the testing of engines, boilers, and water-wheels of neighboring mills and electric plants. The Knowles and the Gordon pumping engines at the City Water Works have been fitted up by the company with especial reference to the convenience of engineering students in making tests. The equipment contains, among other things, a 100,000-pound Olsen testing machine; a 2,000-pound cement testing machine; Thurston and Ashcroft oil testing machines; a Stirling boiler for high pressure; a high speed automatic engine; a Corliss engine; a Rider hot-air engine; Wheeler and Wainwright surface condensers; an Alden absorption dynamometer; a Giddings traction recording dynamometer; an Emerson power-scale; several other forms of dynamometers; a large, electrically driven chronograph, built in the laboratory; a 36-foot open mercury column; special apparatus for testing pressure and vacuum-gauges and indicator springs; gauges; indicators; thermometers; pyrometers; tachometers; standard weights; steam pumps and injectors; rotary and centrifugal pumps; water meters; water motors, including a special universal water motor, built in the laboratory, together with pressure tanks and pumps for testing motors; hydraulic rams; water-wheels; air-pumps; blowers; apparatus for making tests on radiators and pipe coverings; apparatus for furnace gas analysis; a street railway motor; and other apparatus having special reference to work of investigation.

A large addition to the building has just been completed, and increased equipment and facilities for experimental work will soon be ready.

Electrical Laboratory.

The entire ground floor of the physical laboratory is devoted to experimental work in electricity. The rooms for electrical measurements contain solid stone-capped piers, and currents under a pressure ranging from 2 to 220 volts are available.

The laboratory is supplied with apparatus from the best American and European makers. It contains galvanometers and resistance boxes up to 250,000 units from Edelmann, Hartmann & Braun, Elliott Brothers, Nalder Brothers & Co., Queen & Co., Willyoung & Co., and Otto Wolff; a series of ammeters and voltmeters from the Weston Co., for both direct and alternating currents; also wattmeters, condensers, electrodynamometers, electrostatic voltmeters, three Kelvin balances, standard cells, standard resistance coils with certificates from the Reichsanstatt, standard condensers, and an Ayrton & Perry standard of self-inductance.

In the dynamo room are two 10-light arc machines, two constant potential machines, and a 33 K. W. composite wound alternator made for the University by the Fort Wayne Electrical Corporation, and an 8 K. W. rotating converter. These are all run by electric motors varying from 2½ to 50 horse-power. In addition, two small alternators of 60 and 125 cycles respectively are used for two-phase and three-phase experimental work. Arc lamps, banks of incandescent lamps, resistances, rheostats, transformers, and storage batteries complete the equipment. The transformers include a set for conversion from two-phase to three-phase transmission and the reverse. A well-equipped photometric room adjoins the dynamo room.

The new University lighting plant, consisting of two 75 K. W. Thompson-Ryan generators and one 25 K. W. Westinghouse generator, is available for instruction in the department. The two large machines are connected by the Arnold system to two 15 by 14 engines and run at a speed of 250 revolutions per minute. The Westinghouse machine is directly connected to a Russell 9 by 12 automatic engine running at 300 revolutions per minute. The latter is located at the hospitals. These may be lighted independently, or may be supplied with current from the central plant on the campus by means of heavy mains and a "booster." The system is a 220-volt one throughout, with both incandescent and arc lamps (two in series) on the same circuits. All the feeders and mains are underground, except those running from the central plant to the hospitals and to the observatory.

The Arnold system permits of connecting either dynamo to either engine, or of disconnecting either so that it may be tested for efficiency by purely electrical methods. A large number of motors, varying in capacity from 1 to 50 H. P., are in service, and are available for testing purposes.

Astronomical Observatory.

The observatory is known as the Detroit Observatory, having been founded through the liberality of citizens of Detroit. Valuable additions and improvements have been made by contributions from several sources. The building consists of a main part, with a movable dome, and two wings. The meridian circle in the east wing was constructed by Pistor & Martins, of Berlin. In the main part are mounted clocks by Tiede & Howard. The west wing contains the observatory library, which connects with the residence of the Director. The refracting telescope, mounted in the dome, has an object glass thirteen inches in diameter. It was constructed by the late Henry Fitz, of New York.

A small observatory near the main building is used in the work of instruction. It contains an equatorial telescope of six inches aperture, and a transit instrument of three inches aperture, with zenith telescope attachment. A certain amount of practice in determination of time, latitude, and longitude is required of all civil engineering students.

Geological Laboratory.

Opportunity for practical work in geology is provided in rooms set apart for this use in the Museum building. The rooms are furnished with microscopes, photographic instruments, cutting and polishing lathes, and other apparatus for the preparation of specimens. Special encouragement and assistance are given to students wishing to carry on original investigations.

The Libraries.

The various libraries of the University contain about 133,000 volumes, and include a number of important special collections. The portion devoted to engineering contains the standard works in this department of science, and the files of important society proceedings and professional periodicals. Seven hundred and seventy-five periodicals are received.

The catalogue of the library is the usual card catalogue of authors and subjects.

Members of the Faculties and other officers of the University may draw books from the library, subject to certain restrictions. To all other persons it is a reference library. The reading room for general use will seat 210 readers. Separate rooms are provided for advanced students where work is pursued with the necessary books at hand.

The library is open for consultation fourteen hours daily during the academic year, nine hours daily during the six weeks of the Summer School, and six hours daily from the close of the Summer School until the end of the summer vacation. The only exceptions to the above are Sundays and legal holidays.

The Engineering Society.

Several organizations of students are maintained, aside from the usual literary societies, for the reading of papers and holding discussions in various scientific lines. The Engineering Society, composed of and officered by students of this department, holds meetings, at which papers of technical interest are read, and reports made upon observation and experiments. A reading room is maintained by the society, accessible to all students of the department. Several engineers of prominence have spoken before the Society in past years. An annual, called the Technic, containing papers read before the Society, abstracts of theses, contributed articles from alumni, and other matters of professional interest, is published by the students.

The Summer School.

The Summer School, in session from July 1 to August 10, 1901, affords opportunity for study in languages, history, mathematics, natural, physical, and applied science, and for work in the drawing rooms and laboratories. Students who wish to review studies preparatory to presenting themselves for examination for admission to the Department of Engineering will find courses directly adapted to meet their wants. A special Announcement can be had by addressing Mr. James H. Wade, Steward of the University.

The Laboratories.— For a full account of all the laboratories and their various resources, as also of the University collections for the study of art, archeology, ethnology, mineralogy, paleontology, systematic zoology, etc., consult the annual Calendar, which may be had gratis on application to Mr. James H. Wade, Steward of the University. Those laboratories closely connected with the Department of Engineering are described in the preceding pages.

University Organizations.— An attractive series of lectures and musical entertainments is provided each year at a low price by the Students' Lecture Association. The Choral Union is an organization of students and others for the study and practice of choral music.

A course of concerts and a festival of three days in May are announced under its auspices each year.

The Oratorical Association fosters an interest in oratory, and its members have been remarkably successful in recent contests.

FACILITIES FOR PHYSICAL CULTURE.

Waterman Gymnasium.— The University is provided with an excellent Gymnasium which has cost about $65,000. The main floor, which is a rectangle with truncated corners and dimensions of 150 by 90 feet, is well equipped with the various kinds of apparatus usually found in the best modern gymnasiums. A number of smaller rooms are devoted to administration, fencing, boxing, and other special purposes, while the basement is given up to baths and lockers. The main hall is lighted in the daytime by means of a large skylight 60 feet above the floor, and in the evening by electricity. A gallery makes room for an elliptical running-track 375 feet in length.

In the conduct of the gymnasium the aim is not so much the development of a few gymnastic experts as the provision of wholesome physical exercise for the many. Attendance twice a week is required of all first year students. The facilities of the building, including physical examinations and instruction, are free to all students, the only charge being a rental of $2 a year for a locker.

An athletic field of ten acres has been set apart and equipped for open air sports. Room is also provided for tennis courts. Foot-ball and base-ball are practiced by class and University teams.

COURSES OF INSTRUCTION.

The Courses of Instruction are subject to change from time to time; those announced for the year 1900-1 and required for graduation, as stated on pages 50 to 52, are described below, together with some advanced elective and technical courses, which are designated accordingly. The amount of credit towards graduation assigned to each course is indicated by the expressions *one hour, two hours,* etc., an *hour of credit* being given for the satisfactory completion of work equivalent to one exercise a week during one semester. Lectures and recitations are usually one hour in length, but in laboratory work, drawing, and other practical exercises, a longer attendance is required in order to secure an hour of *credit.*

The courses given in the Department of Literature, Science, and the Arts, are (with the exception of the courses in French and in German, for which special permission is required) all open as electives to engineering students who are qualified to pursue them with advantage.

A student enrolled in the Department of Literature, Science and the Arts, and desiring to elect any work in this Department, must obtain written permission from the Dean of the former Department, have it approved by the Dean of the Engineering Department, and attach the paper to the election slip.

Students will be classified and assigned to sections by a Committee of the Faculty.

RULES AND REGULATIONS.

The work of students must be arranged in conformity with the following regulations: —

a. Before entering on any study the student must give the instructor satisfactory evidence that he is prepared to pursue it with advantage.

b. No student will be allowed to elect merely a part of a course, without special permission of the Faculty.

c. No credit will be allowed to a student for work in any course, unless the election of the work is formally made and reported to the Registrar before the work is begun.

d. After the first Saturday of each semester no study can be taken up or dropped without special permission of the Faculty. All requests for permission to take up or drop studies must be made in writing on specially provided blank forms and in accordance with the rules printed thereon.

e. The Faculty requires a student to drop a part of his work at any time, if in its opinion he is undertaking too much; or to take additional work, if it thinks he is not sufficiently employed.

f. The Faculty reserves the right to withdraw the offer of any elective study not chosen by at least six persons.

g. In cases of exceptional proficiency, permission to take hours in addition to those named in the published schedule is granted by the Faculty on special request; but in all cases requests for permission to take an additional number of hours must be made in writing on a blank form provided by the Dean, and must be deposited in the *Dean's box on or before the first Saturday* of the semester during which the additional work is desired. No permission to take extra hours will be granted to students in their first semester of residence.

h. After matriculation, a student can not, without special permission of the Faculty, be admitted to examination in any one of the courses given, until he has received in the University the regular instruction in such course.

French.

FIRST SEMESTER.

A. Beginners' Course. *Three hours.* Mr. GAUSS.

C. or D. Scientific Reading. *Three hours.* Mr. GAUSS.

SECOND SEMESTER.

B. Narrative Prose. *Three hours.* Mr. GAUSS.

E. Current Scientific Literature. *Three hours.* Mr. GAUSS.

German.

FIRST SEMESTER.

A. Elementary Course. Thomas's German Grammar, and a German Reader. *Three hours.* Mr. DIETERLE.

C. or D. Scientific Reading. *Three hours.* Mr. DIETERLE.

SECOND SEMESTER.

B. Elementary Course, continued. *Three hours.* Mr. DIETERLE.

E. Scientific Reading, continued. *Three hours.* Mr. DIETERLE.

English.

FIRST SEMESTER.

1. Paragraph Writing. *Two hours.* Mr. SMITH.

SECOND SEMESTER.

1*a*. Theme Writing. *Two hours.* Mr. SMITH.

Higher language study is pursued in the Department of Literature, Science, and the Arts.

Mathematics.

Students of engineering are required to take in order Courses 1, 2, 3, 4, and 6. They are also required to take Course 1*b*, unless they have passed a satisfactory examination for admission in plane trigonometry, but no credit toward graduation is given to engineering students for Course 1*b*. Other and advanced courses are given in the Department of Literature, Science, and the Arts.

FIRST SEMESTER.

1. Algebra and Analytic Geometry (I). *Four hours.* Dr. GLOVER, Mr. BUTTS, Mr. ESCOTT, and Mr. FORD.

1*b*. Plane Trigonometry. *Two hours.* Dr. GLOVER, Mr. BUTTS, Mr. ESCOTT, and Mr. FORD.

3. Calculus. *Five hours.* Professor ZIWET, Assistant Professor MARKLEY, and Mr. BUTTS.

6. Calculus and Mechanics (II). *Five hours.* Professor ZIWET and Dr. GLOVER.

SECOND SEMESTER.

2. Analytic Geometry (II). *Four hours.* Dr. GLOVER, Mr. BUTTS, Mr. ESCOTT, and Mr. FORD.

4. Calculus and Mechanics (I). *Five hours.* Professor ZIWET, Assistant Professor MARKLEY, and Mr. BUTTS.

Physics.

FIRST SEMESTER.

2. Heat, Electricity, and Magnetism. Lectures and recitations. *Five hours.* Professor CARHART.

Course 2 must be preceded by Course 1 and a course in general or in analytical chemistry.

3. Physical Laboratory Work for Beginners. This course may be elected as 3*a*, *three hours;* or 3*b*, *two hours.* Professor REED and Mr. DAVENPORT. Fee: for Course 3*a*, $3, for 3*b*, $2.

Course 3 is also given in the second semester. It must be preceded or accompanied by Course 1. Students presenting notebooks from High School physical laboratories approved by this department, by electing Course 3*a*, may be allowed *three hours* of credit for *two hours* of work.

7. Mathematical Electricity and Magnetism. *Three hours.* Professor PATTERSON. (Elective.)

Course 7 must be preceded by Course 2. A knowledge of calculus is required.

8. Heat. Laboratory work. *Two hours.* Mr. BURGESS. (Elective.)

Course 8 must be preceded by Course 2. Fee, $2.

9. Theory of Heat. *Two hours.* Professor CARHART. (Elective.)

SECOND SEMESTER.

1. Mechanics, Sound and Light. Lectures and recitations. *Five hours.* Professor REED.

For Course 1 a knowledge of plane trigonometry is indispensable.

3. Physical Laboratory Work for Beginners. This course may be

elected as 3*a*, *three hours;* 3*b*, *two hours.* Professor Reed and Mr. Davenport. Fee: for Course 3*a*, $3, for 3*b*, $2.

See note to course 3 in first semester.

3*c*. Laboratory Work in Mechanical and Electrical Measurements. *Three hours.* Professors Patterson and Reed. Fee, $3.

Course 3*c* must be preceded by Course 2. It is designed for students who wish to prepare for the study of dynamo-electric machinery.

10. Mathematical Electricity and Magnetism. *Two hours.* Professor Patterson. (Elective.)

Course 10 must be preceded by Course 7.

16. Theories of Solutions, Electrolytes, and the Voltaic Cell. Lectures and laboratory work. *Three hours.* Dr. Guthe. (Elective.)

Course 16 must be preceded by Course 2 in electrical engineering and by Course 1 in chemistry. It is also desirable for the student to have had laboratory work in chemistry. Fee, $1.

Chemistry.

EITHER FIRST OR SECOND SEMESTER.

Other and advanced courses in Chemistry are given in the Department of Literature, Science, and the Arts.

A. Principles of inorganic chemistry. Lectures and recitations. *Three hours.* Dr. Sullivan.

Open to those who have passed the entrance requirements in Chemistry.

1. Qualitative Analysis. Recitations and laboratory work. *Ten hours.* Professor O. C. Johnson and Dr. Sullivan.

3. First Steps in Qualitative Analysis. Recitations and laboratory work. *Five hours.* Professor O. C. Johnson.

Course 3 is continued in Course 3*a*, and the two Courses, 3 and 3*a* together, are equivalent to Course 1 and cover the same ground.

3*a*. Qualitative Analysis in continuation of Course 3. Recitations and laboratory work. *Five hours.* Dr. Sullivan.

35. Special Chemistry. *Five hours.* The work will be selected after consultation with Professor Campbell from the advanced courses offered in the Department of Literature, Science, and the Arts.

FIRST SEMESTER.

10. Organic Chemistry. Lectures and library studies. *Five hours.* Professor Prescott.

Course 10 must be preceded by Course 1 or 3.

31. Chemical Technology. A study of chemical manipulations and reactions on a manufacturing scale. Fuels, water, the acid and alkali industries, cements, glass, and the destructive distillation of coal and wood with recovery of by-products. Lectures and assigned reading. *Five hours.* Mr. WHITE.

Course 31 must be preceded by Course 1 or 3*a*.

SECOND SEMESTER.

4. Quantitative Analysis. Beginning course. Recitations and laboratory work. *Seven hours.* Professor E. D. CAMPBELL.

Course 4 is open to those who have taken Course 1 or 3*a*.

5. Advanced Quantitative Analysis. Laboratory work. *Five hours.* Professor E. D. CAMPBELL.

12. Organic Preparations. Laboratory work. *Two hours.* Dr. GOMBERG.

Course 12 must be preceded or accompanied by Courses 4 and 10.

32. Organic Technology. The industrial chemistry of organic compounds. Starch, glucose, and sugar; fermentation and distillation; fats, oils, and soaps; bleaching and dyeing; tanning; paper making; etc. Lectures and assigned reading. *Five hours.* Mr. WHITE.

Course 32 must be preceded by Courses 10 and 31.

Metallurgy.

FIRST SEMESTER.

1. Fuel and Refractory Material, Iron and Steel. *Three hours.* Professor E. D. CAMPBELL.

Course 1 must be preceded by Course 1 or 3, or by Course A.

2. Micro-Metallography. The study of the microscopic structure of metals as related to their physical and chemical properties. Laboratory work with reading. *One hour.* Professor E. D. CAMPBELL. (Elective.)

Course 2 is open only to those who have taken Course 1, and who receive special permission.

Astronomy.

FIRST SEMESTER.

5. Spherical Astronomy. *Three hours.* Professor HALL.

In Course 5 some standard work on spherical astronomy is rapidly read, and special subjects are given out for discussion. Courses 5 and 9 follow Course 4 and are intended for students interested in geodetic work.

13. Theory of Least Squares. *Two hours.* Professor HALL.

EITHER FIRST OR SECOND SEMESTER.

4. Practical Astronomy. Use of sextant and transit. *Three hours.* Professor HALL.

Course 4 requires a knowledge of spherical trigonometry and of differential and integral calculus.

SECOND SEMESTER.

9. Practical Astronomy: extended course, *Hours and credit to be arranged.* Professor HALL.

Mineralogy.

EITHER FIRST OR SECOND SEMESTER.

1. Lectures and practice. *Two hours.* Professor PETTEE.

For Course 1 an elementary knowledge of chemistry is desirable.

Geology.

FIRST SEMESTER.

12. Elements of Geology. Text-book and lectures. *Three hours.* Professor RUSSELL.

Drawing.

FIRST SEMESTER.

1. Geometrical Drawing. *Two hours.* Mr. GOULDING and Mr. GREEN.

4. Free-Hand Drawing; Pencil Drawing; Pen and Ink Drawing; Sketching. *Three hours.* Professor DENISON, Mr. WRENTMORE, Mr. GOULDING, and Miss HUNT.

10. Continuation of Course 8. *Two hours.* Professor DENISON and Miss HUNT. (Elective.)

Course 10 must be preceded by Courses 4, 7, and 8.

13. Water-Color Drawing. *Three hours.* Professor DENISON and Miss HUNT. (Elective.)

Course 13 must be preceded by Course 8. It can be taken only by special permission.

SECOND SEMESTER.

5. Descriptive Geometry. Recitations and drawing. *Four hours.* Professor DENISON, Mr. WRENTMORE, Mr. GOULDING, and Mr. GREEN.

Course 5 must be preceded by Course 1.

6. Shades, Shadows, and Perspective. *Three hours.* Professor DENISON. (Elective.)

Course 6 must be preceded by Course 5.

7. Free-Hand Drawing (advanced). *Three hours.* Professor DENISON and Miss HUNT. (Elective.)

8. Architectural and Water-Color Drawing. *Two hours.* Professor DENISON and Miss HUNT. (Elective.)

Course 8 must be preceded by Course 1 or 4.

14. Stereotomy. *Two hours.* Professor DENISON.

Course 14 must be preceded by Course 5.

16. Free-Hand Lettering. *Two hours.* Mr. WRENTMORE. (Elective.)

Course 16 must be preceded by Course 1.

17. Spherical Projections. *One hour.* Professor DENISON. (Elective.)

Course 17 must be preceded by Course 5.

Shop Practice.

All courses in shop practice are under the direction of Superintendent Wm. L. Miggett. Instruction is given in the various branches by the special shop assistants. Lectures are given by the Superintendent upon general workshop construction, equipment, and management.

Courses 1*a* to 5*a* may be continued by advanced students as Courses 1*b* to 5*b*.

Special arrangements are made for students who desire to take more advanced work in the shop courses with a view to preparing themselves for teaching these subjects.

EITHER FIRST OR SECOND SEMESTER.

1*a*. Wood Work and Pattern Work. *Two hours.* Mr. PURFIELD. Fee, $5.

1*b*. Pattern Work, advanced. *Two hours.* Mr. PURFIELD. Fee, $5.

2*a*. Forging. *Two hours.* Mr. McDONALD. Fee, $5.

3*a*. Foundry Work. *Two hours.* Mr. WINSLOW. Fee, $5.

4*a*. Iron Work. *Three hours.* Mr. COBB. Fee, $5.

4*b*. Iron Work, advanced. *Two hours.* Mr. COBB. Fee, $5.

5*a*. Instrument Work. *Two hours.* Mr. MILLER.

Surveying.

FIRST SEMESTER.

1. Lectures, Text-book, and Field Practice. *Five hours.* Professor J. B. DAVIS.

The field practice in Course 1 continues during favorable weather until Christmas.

4. Use of instruments. *One hour.* Profesor J. B. DAVIS.

SECOND SEMESTER.

2. Continuation of Course 1. Lectures and text-book. *Five hours.* Professor J. B. DAVIS.

Course 2 must be preceded by Course 1.

3. Field Wcrk in Camp: *Four weeks.* Professor J. B. DAVIS.

Course 3 must be preceded by Courses 1 and 2. Except by special permission it is open only to students who are working for a degree in civil engineering.

5. Topography. Transit and Stadia. Plane Table. Camera. Field Work and Drawing. *Five hours.* Professor J. B. DAVIS.

Course 5 is given for thirteen weeks.

7. Geodesy. Geodetic Methods. Lectures and text-book. *Three hours.* Professor J. B. DAVIS. (Elective.)

Course 7 must be preceded by Courses 1 and 2. It is given five times a week for twelve weeks.

Civil Engineering.

FIRST SEMESTER.

1. Municipal Engineering. Lectures and text-book. *Five hours.* Professor J. B. DAVIS. (Elective.)

4. Graphical Analysis of Structures. *Two hours.* Professor GREENE.

Course 4 must be preceded by Course 3.

6. Engineering. Theory of Construction. *Two hours.* Professor GREENE.

Course 6 must be preceded by Course 4 in mathematics.

7. Engineering Design. *Five hours.* Professor GREENE, and Mr. GREEN.

Course 7 accompanies Course 6.

9. Hydraulics. *One hour.* Professor GREENE.

Course 9 must be preceded by Course 6 in mathematics.

15. Highway Construction. *Two hours.* Professor J. B. DAVIS.

PRIMARILY FOR GRADUATES.

11. Engineering Design (advanced). *Five hours.* Professor GREENE.

12. Water Supply and Sewerage. *Two hours.* Professor GREENE.

SECOND SEMESTER.

2. Tests of Materials. *One hour.* Mr. GREEN. (Elective.)
3. Graphical Analysis of Structures. *Two hours.* Professor GREENE.

   Course 3 must be preceded by Course 4 in mathematics.
5. Strength and Resistance of Materials. *Two hours.* Professor GREENE.

   Course 5 must be preceded by Course 4 in mathematics.
8. Engineering. Theory of Construction. *Three hours.* Professor GREENE.

   Course 8 must be preceded by Courses 3 and 6.
10. Water Supply and Sewerage. *One hour.* Professor GREENE. (Elective.)

    Course 10 follows Course 9.

PRIMARILY FOR GRADUATES.

13. Economics of Railway Location. *One hour.* Professor GREENE.
14. Contracts and Specifications. *One hour.* Professor KNOWLTON.

Mechanical Engineering.

FIRST SEMESTER.

2. Elements of Mechanism. *Two hours.* Professor DENISON.

   Course 2 must be preceded by Course 1 in mathematics, and by Courses 1 and 5 in drawing.
3. Dynamics of Machinery. *One hour.* Mr. ANDERSON.

   Course 3 must be preceded by Course 4 in mathematics, and by Course 1 in physics.
4. Boilers. Steam Engines. *Two hours.* Assistant Professor ALLEN.

   Course 4 must be preceded or accompanied by Course 3.
8. Theory of Machine Design. *Three hours.* Professor COOLEY.

   Course 8 must be preceded by Course 5 in civil engineering.

EITHER FIRST OR SECOND SEMESTER.

6. Machine Design. Machine Tools. *Two hours.* Superintendent MIGGETT.

   Course 6 must be preceded or accompanied by Course 2, and be preceded by Courses 1, 4, 5 in drawing.
9. Laboratory Work. Power Measurements. Machine Testing. *Two hours.* Professor COOLEY, Assistant Professor ALLEN, and Mr. GRIMES. Fee, $5.

   Course 9 must be preceded by Course 3.

It is suggested that Courses 9 and 10, and Courses 11 and 12, be taken in pairs.

10. Machine Design. Hoisting Machinery. *Three hours.* Professor Cooley and Mr. Anderson.

Course 10 must be preceded or accompanied by Course 8, and preceded by Course 6.

11. Laboratory Work. Steam Engineering. *Three hours.* Professor Cooley, Assistant Professor Allen, and Mr. Grimes. Fee, $5.

Course 11 must be preceded or accompanied by Courses 4 and 7, or 15.

12. Machine Design. Boilers and Engines. *Two hours.* Professor Cooley and Mr. Anderson.

Course 12 must be preceded or accompanied by Course 8, and preceded by Course 6.

SECOND SEMESTER.

1. Elements of Machines. Nomenclature. *Two hours.* Mr. Anderson.

5. Mechanism: Valve Gears. *Three hours.* Professor Denison.
Course 5 must be preceded by Course 2.

7. Hydraulic Machinery. *One hour.* Professor Cooley.
Course 7 must be preceded by Course 3.

13. Steam Engines and other Heat Engines. *Three hours.* Assistant Professor Allen.
Course 13 must be preceded by Course 4.

14. Power Plants. Power Transmission. *Two hours.* Professor Cooley.

Course 14 must be preceded by Courses 4 and 7.

15. Prime Movers. Water-wheels and Steam Engines. *Two hours.* Professor Cooley.

PRIMARILY FOR GRADUATES.

FIRST SEMESTER.

16. Heating and Ventilation. *Two hours.* Assistant Professor Allen.

Course 16 must be preceded by Course 4.

18. Hydraulic Machinery. *Two hours.* Professor Cooley.
Course 18 must be preceded by Course 7 or 15.

19. Gas Engines. *Two hours.* Professor Cooley.
Course 19 must be preceded by Course 13.

20. Laboratory Work. Advanced Course. *Two hours.* Assistant Professor Allen.

Course 20 must be preceded by Courses 9 and 11.

SECOND SEMESTER.

17. Compressed Air. Mechanical Refrigeration. *Two hours.* Professor COOLEY.

    Course 17 must be preceded by Course 13.

21. Specifications and Contracts. *One hour.* Professor KNOWLTON and Professor COOLEY.

    Course 21 must be preceded or accompanied by Course 14.

22. Thermodynamics. *Three hours.* Assistant Professor ALLEN.

    Course 22 must be preceded by Course 13.

23. Machine Design (advanced). *Three hours.* Mr. ANDERSON.

    Course 23 must be preceded by Courses 10 and 12.

Electrical Engineering.

FIRST SEMESTER.

2. Electrical Measurements: Recitations and laboratory work. *Four hours.* Professor PATTERSON and Mr. BURGESS. Fee, $3.

   Course 2 must be preceded by Courses 1, 2, 3, in physics; a knowledge of calculus is required.

5. Alternate Current Apparatus. Recitations and laboratory work. *Three hours.* Professor CARHART and Mr. JONES. Fee, $1.

   Course 5 must be preceded by Course 4.

6. Photometry of Electric Lamps. Recitations and laboratory Work. *One hour.* Mr. JONES. Fee, $1.

7. Design of Electrical Machinery and Appliances. *Four hours.* Professor CARHART and Mr. JONES.

   Course 7 must be preceded by Course 4.

SECOND SEMESTER.

1. Primary and Secondary Batteries. Recitations and laboratory work. *Two hours.* Professor CARHART and Mr. BURGESS. Fee, $1.

   Course 1 must be preceded by Courses 1, 2, 3, in physics, and a course in general or analytical chemistry.

3. Electrical Measurements. Continuation of Course 2. Lectures and laboratory work. *Three hours.* Professor PATTERSON and Mr. BURGESS. Fee, $2.

4*a*. Dynamo-electric Machinery. Lectures, recitations, and laboratory work. *Four hours.* Professor CARHART and Mr. JONES. Fee, $2.

   Course 4a must be preceded by Course 2.

4*b*. Dynamo-Electric Machinery, as in Course 4*a*. *Three hours.* Professor CARHART and Mr. JONES. Fee, $1.

Course 4*b* must be preceded by Course 3*c* in physics.

8. Distribution of Electricity. Lectures and recitations. *Two hours.* Mr. JONES.

Course 8 must be preceded by Course 4.

10. Advanced Course in Design of Electrical Apparatus. Drawing. *Two hours.* Mr. JONES.

11. Telephone and Telegraph. *Two hours.* Professor PATTERSON.

Course 11 must be preceded by Course 4.

PRIMARILY FOR GRADUATES.

9. Alternating Current Phenomena. *Two hours.* Professor CARHART.

Course 9 must be preceded by Course 5.

Mining Engineering.

SECOND SEMESTER.

1. Exploitation of Mines. Methods of opening, laying out, and working mines. *Five hours.* Professor PETTEE. (Elective.)

Course 1 requires a knowledge of mineralogy and general geology.

Naval Architecture and Marine Engineering.

See note on next page.

FIRST SEMESTER.

1. Naval Architecture. Ship Calculations and Practical Shipbuilding. *Three hours.* Professor SADLER.

Course 1 is designed for graduates or undergraduates who have had the necessary training.

2. Naval Architecture. Drawing. *Two hours.* Professor SADLER.

Course 2 must be accompanied by Course 1.

3. Marine Engines. *Three hours.* Professor COOLEY.

Course 3 is designed for graduates or for undergraduates who have had the necessary training.

4. Naval Architecture. Strength, Stability, and Ship Design. *Two hours.* Professor SADLER.

6. Naval Architecture. Drawing. *Five hours.* Professor SADLER.

Course 6 must be accompanied by Course 4.

SECOND SEMESTER.

1. Naval Architecture. Ship Calculations and Practical Shipbuilding. *Three hours.* Professor SADLER.

Course 1 is designed for graduates or for undergraduates who have had the necessary training.

2. Naval Architecture. Drawing. *Two hours.* Professor SADLER.

Course 2 must be accompanied by Course 1.

5. Marine Engines. *Two hours.* Professor SADLER.
7. Naval Architecture. Stability and Resistance. *Five hours.* Professor SADLER.

Course 7 must be preceded by Course 4.

8. Naval Architecture. Drawing. *Three hours.* Professor SADLER.

Course 8 must be accompanied by Course 7.

9. Marine Engines. Drawing. *Two hours.* Professor SADLER.

The student may choose either Course 8 or Course 9.

10. Naval Architecture. Advanced reading. *Three hours.* Professor SADLER.

For undergraduates desiring to take Naval Architecture as a graduate course, the following order is recommended: —

FOURTH YEAR — SECOND SEMESTER.

Naval Architecture. Courses 1 and 2.

FIFTH YEAR — FIRST SEMESTER.

Marine Engines. Course 3.
Naval Architecture. Courses 4 and 6.

SECOND SEMESTER.

Marine Engines. Courses 5 and 9.
Naval Architecture. Courses 7, 8, and 10.

Graduate students desiring to finish this course in one year's residence, must make the following election of studies: —

FIFTH YEAR — FIRST SEMESTER.

Naval Architecture. Courses 1, 2, 4, and 6.
Marine Engines, Course 3.

SECOND SEMESTER.

Marine Engines. Courses 5 and 9.
Naval Architecture. Courses 7, 8, and 10.

SEQUENCE OF STUDIES.

The studies of the first and second years are *prescribed*, except so far as credit obtained in advance may leave a place for substitutions, or the presentation of Latin as one of the requirements for admission may make some change necessary. In the third and fourth years some opportunity for elective studies is open. The work for the first year is the same for all students. At the end of the first year, the student makes his choice to continue in the civil engineering, the mechanical engineering, the electrical engineering, or the chemical engineering course.

ORDER OF STUDIES.

First Year.

The same for all regular students.

FIRST SEMESTER.

	EXERCISES PER WEEK.
French or German C or D.*	3
English 1, Paragraph Writing.	2
Mathematics 1, Algebra and Analytic Geometry, I.	4
Drawing 1, Elementary Drawing.	2
Drawing 4, Freehand Drawing.	3
Shop Practice *2a*, Forging (one-half of class); or *1a*, Woodwork (one-half of class).	2
	16

SECOND SEMESTER.

French or German E.	3
Physics 1, Mechanics, Sound and Light.	5
Mathematics 2, Analytic Geometry, II.	4
Drawing 5, Descriptive Geometry.	4
Shop Practice *1a*, Woodwork, or *2a*, Forging.	2
	18

Second Year.

The student will now select his course and mark it on his classification slip. Studies marked C, M, E, and Ch. are to be taken by civil, mechanical, electrical, and chemical engineering students respectively.

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* The student who enters with German will continue that language through the first year and begin French in the second year. The student who enters with French will continue French a year and then begin German. The student who enters with *Latin will* take French or German A.

FIRST SEMESTER.

German or French A, Beginners' Course.		3
Physics 2, Heat, Electricity, and Magnetism.		5
Mathematics 3, Calculus.	C, M, E	5
Physics 3*b*, Laboratory Work.	E	2
Analytical Chemistry 1, Qualitative Analysis.	Ch	10
Mineralogy 1.	C	2
Geology 12, Elements.	C	3
Shop Practice 1*b*, Woodwork, advanced.	M	2
Shop Practice 3*a*, Foundry, or 4*a*, Ironwork. (One-half of class.) (One-half of class.)	M, E	2 or 3
		C 18; M, E 17 or 18; Ch 18

SECOND SEMESTER.

German or French B.		3
English 1*a*, Theme Writing.		2
Mathematics 4, Calculus and Mechanics, I.	C, M, E	5
Physics 3*c*, Mechanical and Electrical Measurements.	C, M, Ch	3
Chemistry A.	C	3
Analytical Chemistry 4, Quantitative Analysis.	Ch	7
Drawing 14, Stereotomy.	C	2
Shop Practice 1*b*, Woodwork, advanced.	E	2
Shopwork Practice 4*a*, Ironwork, or 3*a*, Foundry.	M, E	3 or 2
Mechanical Engineering 1, Elements of Machines.	M	2
Electrical Engineering 1, Primary and Secondary Batteries.	E	2
		C 18; M 18 or 17; E 17 or 16; Ch 15

Third Year.

FIRST SEMESTER.

French or German C or D.		3
Mathematics 3, Calculus.	Ch	5
Mathematics 6, Calculus and Mechanics, II.	C, M, E	5
Chemistry A.	M	3
Analytical Chemistry 10, Organic Chemistry.	Ch	5
Analytical Chemistry 31, Chemical Technology.	Ch	5
Shop Practice 4*b*, Ironwork, advanced.	M	2
Surveying 1, Instruction and Practice.	C	5
Mechanical Engineering 2, Mechanism, Elements.	C, M, E	2

Mechanical Engineering 3, Dynamics of Machinery.	C, M, E	1
Mechanical Engineering 4, Boilers, Steam Engines.	M	2
Mechanical Engineering 6, Design of Machine Tools.	E	2
Electrical Engineering 2, Electrical Measurements.	E	4

C 16; M, Ch 18; E, 17

SECOND SEMESTER.

Mathematics 4, Calculus and Mechanics, I.	Ch	5
Analytical Chemistry 5, Quantitative Analysis, advanced.	Ch	5
Analytical Chemistry 12, Organic Preparations.	Ch	2
Analytical Chemistry 32, Organic Technology.	Ch	5
Shop Practice 4*b*, Ironwork, advanced.	E	2
Surveying 2, Advanced Surveying.	C	5
Surveying 3, Field Work in Camp.	C	
Surveying 5, Topography.	C	5
Civil Engineering 3, Graphics.	C, M, E	2
Civil Engineering 5, Resistance of Materials.	C, M, E	2
Mechanical Engineering 5, Mechanism, Valve Gears.	M, E	3
Mechanical Engineering 6, Design of Machine Tools.	M	2
Mechanical Engineering 7, Hydraulic Machinery.	M, E	1
Mechanical Engineering 13, Steam Engines.	M	3
Electrical Engineering 3, Electrical Measurements, advanced.	E	3
Electrical Engineering 4*a*, Dynamo-Electric Machinery	E	4
Electrical Engineering 4*b*, Dynamo-Electric Machinery.	C, M	3

C 17; M 16; E 17; Ch 17

Fourth Year.

FIRST SEMESTER.

Mathematics 6, Calculus and Mechanics, II.	Ch	5
Chemistry A.	E	3
Astronomy 4,* Time, Latitude, and Longitude.	C	3
Metallurgy 1, Fuel, Iron, and Steel.	M, Ch	3
Surveying 4, Use of Instruments.	M, Ch	1
Civil Engineering 4, Graphics, advanced.	C	2
Civil Engineering 6, Trusses and Structures.	C	2
Civil Engineering 7, Design of Structures.	C	5
Civil Engineering 9, Hydraulics.	C, M	1
Civil Engineering 15, Highway Construction.	C	2
Mechanical Engineering 2, Mechanism.	Ch	2

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* One-half of the class will be given instruction in the first semester, the other half in the second semester.

Mechanical Engineering 3, Dynamics of Machinery.	Ch	1
Mechanical Engineering 4, Boilers, Steam Engines.	E, Ch	2
Mechanical Engineering 8, Theory of Machine Design.	M	3
Mechanical Engineering 10*, Design of hoisting Machinery.	M	3
Mechanical Engineering 11, Steam Engineering, Laboratory.		
Mechanical Engineering 9, Power Measurements, Laboratory.	M	2
Mechanical Engineering 12*, Designs of Boilers and Engines.		
Electrical Engineering 5, Alternate Current Apparatus.	E	3
Electrical Engineering 6, Photometry.	E	1
Electrical Engineering 7, Design of Electrical Machinery and Appliances.	E	4
	C 12 or 15; M 13; E 13; Ch 14	

SECOND SEMESTER.

Analytical Chemistry 35, Special Chemistry	Ch	5
Astronomy 4†, Time, Latitude, and Longitude.	C	3
Civil Engineering 8, Theory of Construction.	C	3
Mechanical Engineering 6, Design of Machine Tools.	Ch	2
Mechanical Engineering 7, Hydraulic Machinery.	Ch	1
Mechanical Engineering 10 or 11. (See 1st Semester.)	M	3
Mechanical Engineering 9 or 12. (See 1st Semester.)	M	2
Mechanical Engineering 14, Power Plants, Transmission.	M	2
Mechanical Engineering 15, Prime Movers.	C	2
Electrical Engineering 4*b*, Dynamos.	Ch	3
Electrical Engineering 8, Distribution of Electricity.	E	2
Naval Architecture and Marine Engineering, see page 45.		
Thesis.	C 5 or 8; M 7; E 2; Ch 11	

Total exercises prescribed, C 123; M 123; E 117; Ch 127.

Required for graduation, 130 exercises.

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* One-half of the class will take 9 and 10, the other half 11 and 12.

† One-half of the class will be given instruction in the first semester, the other half in the second semester.

REQUIREMENTS FOR GRADUATION.

The Degree of Bachelor of Science.

To earn the degree of Bachelor of Science in civil, mechanical, electrical or chemical engineering, the student must secure *one hundred and thirty Hours of Credit** in a prescribed course of study, as given below, and must present a satisfactory *thesis*. The diploma given indicates the line of study pursued. A time limit is not fixed; but four years is usually needed for the completion of the 130 hours of work.

Bachelors of Arts, of Philosophy, of Science, and of Letters, of this University, and graduates of any other reputable college, are excused from some portions of the general requirements, and are recommended for the same degree with the regular students upon completing the remaining requirements. This work can be done in two years, if the candidate has previously made considerable progress in mathematics and science. The culture imparted by classical or other liberal training will be found to have its uses for one engaged in engineering work, and previous discipline of the faculties in exact research will enable the professional student to master more easily the requirements of the course. All the time the student can devote to general studies before taking up specialties will be well spent.

A choice between the four courses in engineering need not be made before the end of the first year.

GENERAL REQUIREMENTS.

The *general requirements* are as follows:—

In French and German: fifteen hours, viz.: Courses A, B, C, in one language, and Courses D, E, in the other.
In English: Courses 1, *1a*.
In Mathematics: Courses 1, 2, 3, 4, 6.
In Physics: Courses 1, 2.
In Drawing: Courses 1, 4, 5.
In Shop Practice: Courses *1a*, *2a*.
In Mechanical Engineering: Courses 2, 3.

SPECIAL REQUIREMENTS.

The *special requirements* in the several courses are as follows:—

1. *In Civil Engineering.*

To obtain the recommendation of the Faculty for the degree of

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* *For* explanation of the term Hour of Credit see page 32, and for further information in regard to the courses prescribed for graduation, see pages 34 to 44.

Bachelor of Science in Civil Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows: —

In Physics: Course 3*c*.

In Chemistry: Course A.

In Mineralogy: Course 1.

In Geology: Course 12.

In Astronomy: Course 4.

In Drawing: Course 14.

In Surveying: Courses 1, 2, 3, 5.

In Civil Engineering: Courses 3, 4, 5, 6, 7, 8, 9, 15.

In Mechanical Engineering: Course 15.

In Electrical Engineering: Course 4*b*.

In Elective Studies, taken in the department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

2. *In Mechanical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Mechanical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows: —

In Physics: Course 3*c*.

In Chemistry: Course A.

In Metallurgy: Course 1.

In Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.

In Surveying: Course 4.

In Civil Engineering: Courses 3, 5, 9.

In Mechanical Engineering: Courses 1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.

In Electrical Engineering: Course 4*b*.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

3. *In Electrical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Electrical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Physics: Course 3*b*.

In Chemistry: Course A.

In Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.

In Civil Engineering: Courses 3, 5.

In Mechanical Engineering: Courses 4, 5, 6, 7.

In Electrical Engineering: Courses 1, 2, 3, 4*a*, 5, 6, 7, 8.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure *one hundred and thirty Hours of Credit.*

4. *In Chemical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Chemical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows: —

In Physics: Course 3*c*.

In Analytical Chemistry: Courses 1, 4, 5, 10, 12, 31, 32, 35.

In Metallurgy: Course 1.

In Surveying: Course 4.

In Mechanical Engineering: Courses 4, 6, 7.

In Electrical Engineering: Course 4*b*.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

GRADUATE COURSES.

The Degree of Master of Science.

A candidate for the degree of Master of Science in this Department must have previously received the engineering degree of Bachelor of Science from this University, or, if graduated elsewhere, must satisfy the Faculty that he possesses equivalent attainments.

He must choose a *major* subject, which shall occupy one-half of his time, from the work given in this Department, and two *minor* subjects, each to occupy one-fourth of his time, to be selected from any work open to engineering students; all of the work, however, shall be subject to the approval of the Faculty. Study and residence for not less than one year will be required. Among the courses described on previous pages, the following are arranged primarily for graduates: —

In Physics: Courses 7, 10, 16.

In Civil Engineering: Courses 11, 12, 13, 14.

In Mechanical Engineering: Courses 16 to 23, inclusive.

In Electrical Engineering: Course 9.

In Naval Architecture and Marine Engineering: Courses 3, 4, 5, 6, 7, 8, 9, 10.

If a candidate for the degree of Master of Science desires to have his work count towards the degree of Civil Engineer,. Mechanical Engineer, or Electrical Engineer, the major subject must be taken in the course in which he took his bachelor's degree, and he must submit a satisfactory thesis before such degree as Engineer will be conferred.

The Degrees of Civil Engineer, Mechanical Engineer, and Electrical Engineer.

The conditions on which the degree of Civil Engineer, as an advanced degree, is conferred are as follows:—

The degree of Civil Engineer may be conferred upon Bachelors of Science of this University, who have taken the degree for a course in civil engineering, if they furnish satisfactory evidence that they have pursued further technical studies for at least one year, and, in addition, have been engaged in professional work, in positions of responsibility, for another year. The first of the above requirements may be satisfied by pursuing at the University, under the direction of the Faculty, a prescribed course of study for an amount of time, not necessarily consecutive, equivalent to a college year. If the candidate does not reside at the University, his course of study must be approved in advance by the professor of civil engineering, and he must prepare a satisfactory thesis on some engineering topic, to be presented, together with a detailed account of his professional work, one month at least, before the date of the annual Commencement at which he expects to receive the degree.

The condition on which the degrees of Mechanical Engineer, and Electrical Engineer, as advanced degrees, are conferred upon Bachelors of Science of this University who have taken the degree for a course in mechanical engineering, or electrical engineering, are analogous in character and in amount to those given above for the degree of Civil Engineer.

FEES AND EXPENSES.

Matriculation Fee.—Every student before entering any department of the University is required to pay a matriculation fee. This fee, which, for citizens of Michigan, is ten dollars, and for those who come from any other State or country, twenty-five dollars, is paid but once, and entitles the student to the privileges of permanent membership in the University.

Annual Fee.—In addition to the matriculation fee, every student has to *pay an annual fee for* incidental expenses. This fee is paid the first year of residence at the University, and every year of residence thereafter. Resident graduates are required to pay the same annual fee as undergraduates. The annual fee in the Department of Engineering is, for Michigan students, thirty-five dollars; for all others, forty-five dollars.*

The Matriculation Fee and the Annual Fee must be paid *in advance*. No portion of the fees can be refunded, except by order of the Board of Regents, to students who leave the University during the academic year. A by-law of the Board of Regents provides that no student or graduate shall be allowed to enjoy the privileges of the University until he has paid all fees that are due.

Fee for Special Entrance Examinations.— An applicant for admission who desires to take the entrance examination at a time not announced is required to pay to the Treasurer a fee of five dollars before permission to take the examinations can be granted him.

Diploma Fee.— The fee for the diploma given on graduation is ten dollars, and the by-laws of the Board of Regents prescribe that no person shall be recommended for a degree until he has paid all dues, including the fee for diploma.

Laboratory Courses.— The required laboratory courses cost approximately as follows: *Shop Practice.*— In the mechanical and electrical engineering courses, *thirty dollars;* in the civil engineering course, *ten dollars. Physical Laboratory.*— A charge of *one dollar* is made for a course requiring one exercise a week during one semester, and at the same rate for the longer courses. *Mechanical Laboratory.*— The charge for each course is *five dollars. Chemical Laboratory.*— Students who take laboratory courses in chemistry are required to pay for the materials and apparatus consumed by them. The average cost is about *ten dollars.*

The fee required for any course has to be paid before the work of the course is begun.

The total amount of fees paid to the University during the whole four years' course, for matriculation, incidental expenses, materials used, and diploma, is, for Michigan students, from $185 to $210; and for others, from $240 to $265, varying more or less according to the student's actual laboratory expenses.

Other Expenses.— Students obtain board and lodging in private families for from three to five dollars a week. Clubs are also formed in which the cost of board is from one dollar and a half to two dollars and a half a week. Room rent varies from seventy-five cents to two dollars a week for each student. The annual expenses of students, including clothing and incidentals, are, on the average, about three hundred and seventy dollars. The University does not undertake to furnish manual labor to students; yet a few find opportunities in the city for remunerative labor.

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* An annual fee of ten dollars is required of all graduates who are granted the *privilege* of pursuing studies for an advanced degree *in absentia*.

There are no dormitories and no commons connected with the University. Students on arriving in Ann Arbor can obtain information in regard to rooms and board by calling at the Steward's office.

Students are temporary residents of the city, and, like all other residents, are amenable to the laws. If guilty of disorder or crime, they are liable to arrest, fine, and imprisonment. A rule of the University Senate provides that if a student is arrested, or is convicted by the civil authorities, he shall be cited to appear before the Faculty of the department in which he is matriculated, and shall be liable to suspension or expulsion.

Department of Engineering.

GRADUATES OF 1899 AND 1900.

1899.

Emanuel Anderson, (Mechanical). Dftsman, J. S. Metcalf Co. Chicago, '99. With Sargent & Lundy, engrs., '00. Chicago, Ill.

James C. Armstrong, (Electrical and Mechanical). With Alaska Explor. Co. Nome City.

Frederic E. Arnold, (Mechanical). Dftsman and Insp., Whiting Fdy. Equipment Co. Harvey, Ill.

Norwood B. Ayres, (Electrical). Asst. Master Mech., Cudahy Packing Co. Kansas City, Mo.

William P. Baker, (Electrical). Erect. Dept. Gates & Randolph, Chicago. Dftsman, Genl. Elect. Co. Schenectady, N. Y.

John W. F. Bennett, (Civil). With Geo. A. Fuller Co. '99. With Thompson-Starrett Co., '00. New York.

James R. Bibbins, (Electrical). Dftsman, Edison Ill'g Co. Elect'n. Public Lighting Com'n. Detroit.

Joseph A. Bursley, (Mechanical). In Shops of Penn'a Co. Fort Wayne, Ind.

David F. Castilla, (Mechanical). Dftsman, with Foundry Co. Monterey, Mex.

William G. Chesebrough, (Mechanical). Dftsman. Northern Eng'g Wks. Detroit.

James W. Clift, (Mechanical). Dftsman, F. & P. M. R. R. Do. Wickes Bros. Do. Industrial Wks. Bay City.

E. Warren Conable, (Civil). With Barnhart Bros. & Spindler, Type-founders. Chicago, Ill.

William M. Cooper, (Mechanical). With Sterling Boiler Co. Barberton, O. Lumber Business. Saginaw.

Walter T. Curtis, (Civil). Dftsman, Wisconsin Bdge Wks. Asst. Engr. Bdge Dept. C. &. N. W. Ry. Dftsman, Keystone Bdge Wks. Pittsburg, Pa.

Burt J. Denman, (Electrical). Elect. Engr. Toledo & Maumee R. R. Instr. Math., Man. Tr. Sch. Toledo, O.

Bartlett C. Dickinson, (Civil). With Geo. A. Fuller Co., '99. With Thompson-Starrett Co., '00. New York.

John H. Dressel, (Electrical). Testing for Cuttler-Hammer Mfg. Co., Milwaukee. Dftsman, Genl. Electric Co. Schenectady, N. Y.

George H. Gibson, (Electrical). With Westinghouse Elect. & Mfg. Co., '99. Asst. Editor, *Engineering News.* New York.

Harmon A. Harris, (Electrical). Asst. Engr. & Purchasing Agent, Ill. Telephone Const. Co. Chicago, Ill.

Sanford F. Harris, (Electrical). Elect. Engr. Ill. Telephone & Telegraph Co. Chicago, Ill.

Milton C. Hartman, (Electrical). Machine Dept. Siemens & Halske Elect. Co. Dynamo Testing, Western Elect. Co. Eng'g Dept. Edison Co. Chicago, Ill.

Orra E. Heffelbower, (Civil). U. S. Engr. Office. Sault Ste. Marie.

Clinton J. Hixson, (Electrical). Dftsman, Checker, Testing Dept., Asst. Engr., Genl. Elect. Co. Schenectady, N. Y.

Frederick R. Hoover, (Civil). Agent, Wt. Iron Bdge Co. Kansas City, Mo.

James L. Horth, (Mechanical). With U. S. Heater Co. Dftsman, Detroit Bdge Wks. Detroit.

Lewis G. Howlett, (Electrical). Dftsman, Industrial Wks. Asst. Supt. Do. Bay City.

Edwin A. Hughes, (Electrical). Telep. Dept. Western Elect. Co. Elkhart, Ind.

William L. Kimmel, (Electrical). Elect. Engr. & Designer, Grangeville Elect. Light Co. Grangeville, Idaho.

Charles A. La Fever, (Electrical). Elect. Engr., Advance Thresher Co. Asst. Supt. Do. Battle Creek.

Ernest Lunn, (Electrical). With Edison Ill'g Co. Detroit.

Augustus J. Mayworm, (Mechanical). Asst. Engr., Fletcher Paper Co. Do. Alpena Portland Cement Co. Alpena.

William M. Mc Kee, (Electrical). Dynamo-Testing Dept. Western Elect. Co. Paris Exposition.

William M. Miggett, (Mechanical). Supt. of Shops, Eng'g Dept., U. of M. Ann Arbor.

John T. Mountain, (Electrical). Statistician, Chicago Edison Co. Chicago, Ill.

Clarence W. Noble, (Civil). U. S. Coast & Geod. Survey, '99. Dftsman, Mc Clintic-Marshall Const. Co. Pittsburg, Pa.

Ard E. Richardson, (Electrical, Mechanical, '00). Electrician, *Wickes Bros. Engr.,* Amer. Fibre Co. Saginaw.

Wellington Roberts, (Civil). With Isthmian Canal Com'n. Asst. Engr., Algomah Cent. R. R. Sault Ste. Marie.

David N. Rosen, (Mechanical). Dftsman, Central Paper Co. Erecting Dept., Dftsman, Order Dept., E. P. Allis Co. Milwaukee, Wis.

Arthur G. St John, (Civil). Dftsman, Genl. Elect. Co. Transitman, R. R. Location, Grand Rapids, '99. Dftsman, Riter-Conley Mfg. Co., '00. Do. Heyl & Patterson. Pittsburg, Pa.

Cary D. Terrell, (Electrical). Mech. Engr., Banner Lumber Co. Mach. Dept. & Test Crew, Ill. Cent. R. R. Chicago, Ill.

Frank Trott, (Mechanical). Fairbanks-Morse Gas Engine Wks. Beloit, Wis.

Charles H. Weideman, (Mechanical). Dftsman, S. V. Huber & Co. Do. Amer. Steel Hoop Co. Do. Sharon Steel Co. Sharon, Pa.

William R. Weidman, (Mechanical). Dftsman, Amer. Bdge Wks. Do. Scherzer Rolling Lift Bdge Co. Chicago, Ill.

Clarence W. Whitney, (Mechanical). Assoc. Editor, *Western Electrician.* Chicago, Ill.

Bertram D. Wilber, (Electrical). Testing, West. Elect. Co., '99. Asst. Div. Inspector, Cent'l Union Telep. Co., '00. Peoria, Ill.

Arthur B. Wood, (Electrical). Dftsman, Asst. Elect. Engr., Eddy Motor Co. Windsor, Conn.

1900.

Mark B. Beattie, (Electrical). Ann Arbor.

Elias H. Beckstrand, (Electrical). Grad. Student, Cornell. Ithaca, N. Y.

Claude K. Bentley, (Mechanical). Dftsman, Northern Eng'g Wks. Detroit.

Frederic A. Bergbom, (Mechanical). Dftsman, Gates Iron Wks. Chicago, Ill.

Frederick N. Bradley, (Civil). Dftsman, Bdge Dept. C. & N. W. R. R. Chicago, Ill.

Joseph W. Busch, (Electrical). Marquette.

Paul Cheever, (Mechanical). Dftsman, Field & Hinchman. Detroit.

Carl C. Cleverdon, (Mechanical). Dftsman, Pearson Machine Co. Chicago, Ill.

Jenaro Davila, (Civil). Mex. Technical & Financial Co. Monterey, Mex.

Harry H. Dickinson, (Electrical). With J. A. Erner & Co. Columbus, O.

Paul A. Dratz, (Mechanical). City Elect'n, Escanaba. With Field & Hinchman, Detroit. With J. A. Erner & Co. Columbus, O.

David G. Fisher, (Civil). With Toledo Bdge Co. Toledo, O.

Andrew Grabenstein, (Civil). Lake Linden.

Harry D. Harting, (Civil). Rodman, Ill. & Miss. Canal. Sterling, Ill.

E. H. Jacobs, (Electrical). Dftsman, Genl. Electric Co. Schenectady, N. Y.

Lee F. Johnston, B. S. Purdue, (Civil). U. S. Engr. Office. Sault Ste. Marie.

Oscar G. Joseph, (Civil). Mt. Vernon Bdge Wks. Mt. Vernon, O.

Alfred H. Knight, (Mechanical). Grad. Student, Sibley Coll., Cornell Univ. Ithaca, N. Y.

Otto A. Krause, (Mechanical). Hirth, Krause & Co. Grand Rapids.

Robert E. Kremers, A. B. Hope College, (Civil). Dftsman, City Engr. Office. Salt Lake City, Utah.

Willy Lehnartz, (Mechanical). Grad. Student, U. of M. Ann Arbor.

Ora M. Leland, (Civil). U. S. Coast & Geod. Survey. Texas.

Alfred E. Lindau, (Mechanical). With Mich. Bd. of Appraisal. Detroit.

Chester B. Loomis, (Mechanical). With Western Elect. Co. Dftsman, Brooks Locomotive Wks. Dunkirk, N. Y.

Frederick H. Loud, (Civil). Au Sable.

Guy W. Lunn, (Electrical). Elect. Engr., Mich. Telep. Co. Detroit.

Royal J. Mansfield, (Civil). Aide, U. S. Coast & Geod. Survey. Dftsman, Cambria Steel Co. Johnstown, Pa.

Shigeru Matsuyama, (Mechanical). With Cornell Machine Co., Chicago. Tokio, Japan.

Walter B. Maurice, (Civil). With Mich. Bd. of Appraisal. Detroit.

Harry S. Marsh, (Electrical). Asst. Elect. Engr., Pittsburg Plate Glass Co. Fort City, Pa.

Henry A. Mc Lean, (Mechanical). Mayfair, Ont.

Ezra B. Mead, (Mechanical). Ed. Dept., *Construction News.* Chicago, Ill.

William C. Miller, (Electrical). With Edison Ill'g. Co. Detroit.

Frederick N. Nelles, (Civil). Dftsman, Cambria Steel Co.
Johnstown, Pa.

Arthur W. Norton, (Mechanical). With Norton Bros.
Chicago, Ill.

Floyd J. Page, (Mechanical). With Brown Hoist. & Convey. Co.
Cleveland, O.

Clarence J. Rannells, (Civil). With Cambria Steel Co.
Johnstown, Pa.

Anton S. Rosing, (Civil). C. & N. W. R. R. Surveys.
Princeton, Wis.

Richard W. Runge, (Mechanical). With Fairbanks, Morse & Co.
Beloit, Wis.

Harry M. Sedgwick, (Mechanical). With S. Wilks Manfg. Co.
Chicago, Ill.

Alva F. Traver, (Mechanical). Grad. Student, U. of M.
Ann Arbor.

Joseph J. Walser, (Civil). With Goss Printing Press Co.
Chicago, Ill.

Chas. M. Waters, (Civil). Rodman, Ill. & Miss. Canal.
Tampico, Ill.

Frederick J. Wilbur, (Civil). Rodman and Inspector, N. Y. C. & H. R. R. R.
Rochester, N. Y.

Joseph W. Wood, (Electrical). With Frieland Manfg. Co.
Niles.

George D. Wuerfel, (Mechanical). With Toledo Fndy. & Machine Co.
Toledo, O.

Jacob G. Young, (Civil). Dftsman, Chicago Bdge Co.
Chicago, Ill.

A Register of Alumni, 1860-1898, giving positions occupied up to 1899, will be mailed on application by postal to

Chas. E. Greene,
Dean, Dept. of Engineering,
Ann Arbor, Mich.

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1901/02

UNIVERSITY OF MICHIGAN

Department of Engineering

PROGRAM OF HOURS AND WORK

FOR THE YEAR

1901-1902

ANN ARBOR, MICH.
PUBLISHED BY THE UNIVERSITY.
1901.

SCHEDULE OF EXAMINATIONS

In 1901–1902 the Examination Periods begin as follows: For the First Semester on Friday, Jan. 31, and for the Second Semester on Friday, June 6.

Time of Exercise.*	Monday 8	Monday 9	Monday 10	Monday 11	Monday 1	Monday 2	Monday 3
Time of Examination.	Monday 8-10	Tuesday 8-10	Thursday 8-10	Friday 8-10	Thursday 4-6	Tuesday 2-4	Wednesday 2-4
Time of Exercise.	Tuesday 8	Tuesday 9	Tuesday 10	Tuesday 11	Tuesday 1	Tuesday 2	Tuesday 3
Time of Examination.	Saturday 8-10	Wednesday 8-10	Monday 2-4	Thursday 2-4	Friday 4-6	Saturday 4-6	Friday 2-4
Time of Exercise.	Wednesday 8	Wednesday 9	Wednesday 10	Wednesday 11	Wednesday 1	Wednesday 2	Wednesday 3
Time of Examination.	Saturday 10-12	Monday 10-12	Friday 10-12	Wednesday 10-12	Monday 4-6	Tuesday 10-12	Thursday 10-12

*NOTE: By the **Time of Exercise** is meant the time of the first exercise of the week in any given course. For example: If a course is given Monday at 3, Wednesday at 3, and Friday at 10, it is said to be given **Monday at 3.** By referring to Monday 3, in the schedule, it will be seen that the examination falls upon Wednesday 2–4. In courses not provided for, the examinations will be held at hours arranged so as not to conflict with the schedule.

Department of Engineering.

PRELIMINARY NOTICE.

The first semester opens Tuesday, September 24, 1901; the second semester, February 10, 1902. All students are expected to be in attendance on those days. In each branch of study, work will begin at the time and place named in the following program for the first exercise in that study. For all absences, excuses from the Dean must be presented to the instructor.

Members of the fourth year class will elect work under the usual rules, and deposit their election slips at the Dean's office by September 28 and February 15 respectively.

All other students will report at Room 5, Engineering Building, on September 24, and February 10, to be classified and assigned to sections.

All necessary changes after the above dates must be submitted for approval.

In the *General Announcement* of this Department for 1901-2 may be found

Rules relating to Advanced Standing, p, 11.
Rules relating to Courses of Instruction, p. 33.
Sequence of Studies, pp. 46-49.
Requirements for graduation, pp. 50-52.

First year students are limited to *sixteen hours* the first semester. *Eighteen hours* is the maximum limit for the remainder of the course, except by special permission, only granted on a clear record, on petition to the Faculty, on a blank secured from the Dean, and filed with the Dean on or before the *first Monday* after the beginning of the semester.

No student is obliged to elect the maximum number of hours; but one desiring to elect less than *twelve* hours must apply to the Dean for permission.

After classification no study shall be taken up or dropped without permission of the Engineering Faculty. All requests for permission to take up or drop studies must be made in writing on specially provided blank forms and in accordance with the rules printed thereon.

The Faculty will require a student to drop a part of his work at any time, if in its opinion he is undertaking too much; or to take additional work, if it thinks he is not sufficiently employed.

N. B. Students who are making up plane trigonometry, or chemistry, or who are taking preparatory studies in the Ann Arbor High School are required to deduct the time from the maximum number of hours allowed.

A student enrolled in the Department of Literature, Science and the Arts, and desiring to elect any work in this Department, must obtain written permission from the Dean of the former Department, have it approved by the Dean of the Engineering Department, and attach the paper to the election slip.

Courses given in the Department of Literature, Science and the Arts (except in French and German), may be elected by students of this Department, when qualified to take them. For additional work in Language and Science, see the announcement of the former department.

COURSES OFFERED IN 1901–1902.

The courses of study for 1901–1902 will be substantially as described in the following paragraphs, subject to such changes in subjects and instructors as may become necessary.

Students admitted on German will elect German, Courses D and E. in sequence. Those admitted on French will elect French, Courses D and E, in sequence. Those admitted on Latin will begin French or German; but if advanced credit in German or French is secured, Course D should be taken.

FRENCH.

FIRST SEMESTER.

A. Beginner's Course. *Three hours*, Sec. I, *M, W, F*, at 9; Sec. II, *M, W, F*, at 10; Sec. III, *Tu, Th, S*, at 10; Sec. IV, *Tu, W, Th*, at 3. Room 3. Mr. FRANK.

C. D. Scientific Reading. *Three hours.* Sec. I, *Tu, S*, at 8, Room 3, *Th*, at 8, Room 10; Sec. II, *M, W, F*, at 2, Room 7. Mr. FRANK.

SECOND SEMESTER.

B. Narrative Prose. *Three hours.* Sec. I, *M, W. F*, at 9; Sec. II, *M, W, F*, at 10; Sec. III, *Tu, Th*, at 3, *S*, at 10. Room 3. Sec. IV, *Tu, Th*, at 2, *S*, at 9. Room 4. Mr. FRANK.

E. Current Scientific Literature. *Three hours.* Sec. I, M, *W, F*, at 1; Sec. II, *M, W, F*, at 2. Room 4. Mr. FRANK.

GERMAN.

FIRST SEMESTER.

A. Elementary Course. Thomas' German Grammar and a German Reader. *Three hours.* Sec, I, *M*, *W. F*, at 10. Room 5; Sec. II, *Tu*, *W*, *Th*, at 3, Room 10. Dr. WAIT.

C or D. Scientific Reading. *Three hours.* Sec. I, *M*, *W*, *F*, at 11. Room 5. Sec. II, *Tu*, *Th*, *S*, at 10. Room 10. Sec. III, *M*, *W*, *F*, at 2. Room 10. Dr. WAIT.

SECOND SEMESTER.

B. Elementary Course, continued. *Three hours.* Sec. I, *M*, *W*, *F*, at 10. Room 10. Sec. II, *M*, *W*, *F*, at 11. Room 1. Sec. III. *Tu*, *Th*, at 2, *S*, at 9. Room 11. Dr. WAIT.

E. Scientific Reading, continued. *Three hours.* Sec I, *M*, *W*, *F*, at 2; Sec. II, *M*, *W*, *F*, at 3; Sec. III, *Tu*, *Th*, *S*, at 11. Room 11. DR. WAIT.

ENGLISH.

FIRST SEMESTER.

1. Paragraph Writing. *Two hours.* Sec. I, *M*, at 11, *F*, at 2; Sec. II, *M*, at 2, *Th*, at 8; Sec. III, *Tu*, *Th*, at 2; Sec. IV, *M*, *F*, at 1. Room 3. Mr. ———.

SECOND SEMESTER.

1*a*. Theme Writing. *Two hours.* Sec I, *M*, *F*, at 11: Sec. II, *Tu*, *Th*, at 9; Sec. III, *W*, *S*, at 11; Sec. IV, *Tu*, *Th*, at 1. Room 3. Mr. ———.

MATHEMATICS.

The required work is given below, and is to be taken in the order of the numbers. For other and advanced courses in Mathematics, see Announcement of the Department of Literature, Science, and the Arts.

FIRST SEMESTER.

1. Algebra and Analytical Geometry (1). *Four hours.*
Sec. I, *M*, *Tu*, *W*, *F*, at 8, Room 17, U. H., Mr. MARSHALL.
Sec. II, *M*, *Tu*, *W*, *F*, at 9, Room 27, U. H., Mr. ESCOTT.
Sec. III, *M*, *Tu*, *W*, *F*, at 9, Room 1, T. H., Mr. BUTTS.
Sec. IV, *Tu*, *W*, *Th*, *F*, at 10, Room 27, U. H., Mr. ESCOTT.
Sec. V, *M*, *Tu*, *Th*, *F*, at 11, Room 10, Eng. B'ld'g, Mr. ———.
Sec. VI, *M*, *Tu*, *W*. *Th*, at 3, Room 19, U. H., Mr. ———.

1*b*. Plane Trigonometry. *Two hours.* Students who have not passed in trigonometry for admission may enter one of the literary sections in this subject. No credit toward graduation is given. but it must be entered on the election slip.
Sec. I, *Th, S,* at 8, Room 27, U. H., Mr. ESCOTT.
Sec. II, *Tu, Th,* at 9, Room 19, U. H., Mr. ——.
Sec. III, *M, W,* at 10, Room 1, T. H., Mr. BUTTS.
Sec. IV, *Tu, F,* at 11, Room 1, T. H., Mr. BUTTS.

3. Calculus. *Five Hours.*
Sec. I, *M, Tu, W, Th, F,* at 8, Room H, U. H., Professor ZIWET.
Sec. II, *M, Tu, W, Th, F,* at 8, Room 19, U. H., Assistant Professor MARKLEY.
Sec. III, *M, Tu, W, Th, F,* at 8, Room 1, T. H., Mr. BUTTS.
Sec. IV, *M, Tu, W, Th, F,* at 9, Room 17, U. H., Dr. GLOVER.
Sec. V, *Tu, W, Th, F,* at 2, *S,* at 10, Room 17, U. H., Mr. MARSHALL.

6. Calculus and Mechanics (II). *Five hours.*
Sec. I, *M, Tu, W, Th, F,* at 11, Room H, U. H., Professor ZIWET.
Sec. II, *M, Tu, W, Th, F,* at 11, Room 17, U. H., Dr. GLOVER.
Sec. III, *M, Tu, W, Th, F,* at 1, Room H, U. H., Mr. BUTTS.

SECOND SEMESTER.

2. Analytical Geometry (II). *Four hours.*
Sec. I, *M, Tu, Th, F,* at 8, Room 17, U. H., Mr. MARSHALL.
Sec. II, *M, W, F, S,* at 9, Room 27, U. H., Mr. ESCOTT.
Sec. III, *M, W, F, S,* at 9, Room 1, T. H., Mr. BUTTS.
Sec. IV, *M, Tu, Th, F,* at 10, Room 1, T. H., Mr. BUTTS.
Sec. V, *M, Tu, W, Th,* at 11, Room 17, U. H., Dr. GLOVER.
Sec. VI, *M, Tu, W, Th,* at 3, Room 19, U. H., Mr. ——.

4. Calculus and Mechanics (I). *Five hours.*
Sec. I, *M, Tu. W, Th, F,* at 8, Room H, U. H., Professor ZIWET.
Sec. II, *M, Tu, W, Th, F,* at 8, Room 19, U. H., Assistant Professor Markley.
Sec. III, *M, Tu, W, Th, F,* at 8, Room 1, T. H., Mr. BUTTS.
Sec. IV, *M, Tu, W, Th, F,* at 9, Room 17, U. H., Dr. GLOVER.
Sec. V, *M, Tu, W, Th, F,* at 3, Room 17, U. H., Dr. GLOVER

PHYSICS.

The lectures in Physics are given in the lecture room of the Physical *Laboratory*. Courses in Electrical Engineering will be found under that *title*.

FIRST SEMESTER.

2. Heat, Electricity, and Magnetism. *Five hours.* Lectures, *M*, *W*, *F*, at 11. Recitations, *Tu*, *Th*, Sec. I, at 10; Sec. II, at 9; Sec. III, at 11; Sec. IV, at 11; Sec. V, at 1, Professor CARHART.

Course 2 must be preceded by Course 1, and by a course in general or analytical chemistry.

3*b*. Physical Laboratory Work for Beginners. *Two hours.* *M*, *W*, 1–4; Recitations, *M*, at 8, Assistant Professor REED and Mr.———.

This course comprises one lecture or recitation and six hours per week in the laboratory. It should be chosen by electrical engineering students.

Course 3b must be preceded or accompanied by Course 1.

Students presenting note-books from High School physical laboratories approved by this department may be allowed three hours credit for two hours work.

3*c*. Laboratory work in Mechanical and Electrical Measurements. *Three hours.* One lecture or recitation weekly. *Tu*, at 2; *W*, at 11; or *Sat.* at 8. Laboratory, Sec. I, *M*, *W*, 1–4; Sec. II, *Tu*, *Th*, 9–12.

This course is designed for civil and mechanical engineering students who desire to elect Dynamo-Electric Machinery. It must be preceded by Course 2.

7. Mathematical Electricity and Magnetism. *Three hours.* *W*, *F*, *S*, at 8, Professor PATTERSON.

Course 7 must be preceded by Course 2. A knowledge of calculus is also required.

8. Heat. Laboratory work. *Twice a week. Hours to be arranged with instructor.* Assistant Professor GUTHE.

Course 8 must be preceded by Course 2.

9. Theory of Heat: Preston. *Twice a week.* Professor CARHART.

SECOND SEMESTER.

1. Mechanics, Sound and Light. *Five hours.* Lectures, *Tu*, *Th*, at 9, or 11. Assistant Professor REED. Recitations, *M*, *W*, *F*.

Sec. I, at 9, Room 6, T. H.
Sec. II, at 10, Room 5.
Sec. III, at 11, Room 11.
Sec. IV, at 8, Room 4.
Sec. V, at 9, Room 4, T. H.
Sec. VI, at 11, Room 10.
Sec. VII, at 10, Physics Lecture Room.
Sec. VIII, at 11, Physics Lecture Room.

Course 1 is open to those who have passed an entrance examination in physics, A knowledge of plane trigonometry is indispensable.

3*b*. Physical Laboratory Work for Beginners. Repetition of Course 3b, *first semester.* See note in first semester.

3*c*. Laboratory work in Mechanical and Electrical Measurements. *Three hours.* One lecture or recitation weekly. Laboratory, Sec. I, *M*, *F*, 2–5; Sec. II, *Tu*, *Th*, 9–12; Sec. III, W, 2–5, and *S*, 9–12.

This course is designed for civil and mechanical engineering students who desire to elect Dynamo-Electric Machinery. It must be preceded by Course 2.

10. Mathematical Electricity and Magnetism. *Twice a week.* Professor PATTERSON.

Course 10 must be preceded by Course 7.

16. Theories of Solutions, Electrolytes and the Voltaic Cell. *Three hours.* Lectures, *twice a week.* Laboratory work, *once a week.* Assistant Professor GUTHE.

Course 16 must be preceded by Course 2 in electrical engineering and Courses 1 and 4 in general chemistry.

CHEMISTRY.

For elective courses in chemistry, desirable for engineering students, see Announcement of the Department of Literature, Science, and the Arts.

The laboratory is open for work on *M*, *Tu*, *W*, *Th*, *F*, from 8 to 12 A. M., and from 1 to 5 P. M.

EITHER FIRST OR SECOND SEMESTER.

A. Principles of Inorganic Chemistry. Lectures, and Recitations. *Three hours.* *M*, *W*, *F*. at 1. Room B. Chemical Laboratory. Dr. SULLIVAN.

Course A is open to those who have passed the entrance requirement in chemistry.

39. *[35.] Special Chemistry. *Five hours.* The work will be selected after consultation with Professor CAMPBELL, from the advanced courses offered in the Department of Literature, Science, and the Arts.

FIRST SEMESTER.

3. [1.] Qualitative Analysis. *Seven hours,* Recitations, *M*, *Tu*, *W*, *Th*. Sec. I, at 8; Sec. II, at 9. Laboratory work, *three to four times a week.* Professor JOHNSON and Dr. SULLIVAN.

Course 3 [1] must be preceded by Course A.

7. [10.] Organic Chemistry. Lectures and library studies. *M*, *Tu*, *W*, *Th*, *F*, at 10. Professor PRESCOTT.

Course 7 [10] must be preceded by Course 3.

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* *Old* numbers in brackets, as in engineering announcement.

33. [31.] Chemical Technology. A study of chemical manipulations and reactions on a manufacturing scale. Fuels, water, the acid and alkali industry, cements, glass, and the destructive distillation of coal and wood with recovery of by-products. Lectures and assigned reading. *Five hours.* *M, Tu, W. Th, F,* at 11. Room B, Chemical Laboratory. Mr. WHITE.

Course 33 [31] must be preceded by Course 3. [1].

SECOND SEMESTER,

3. [1.] Qualitative Analysis. *Seven hours.* Recitations, *M, Tu, W, Th,* at 8. Laboratory work, *three to four times a week.* Professor JOHNSON and Dr. SULLIVAN.

Course 3 [1] must be preceded by Course A.

5. [4.] Quantitative Analysis. Beginning Course. *Five hours.* Recitation, *Tu, Th,* at 9. Laboratory work, *three times a week.* Professor CAMPBELL.

28. [5.] Advanced Quantitative Analysis. *Five hours.* Laboratory work, *daily.* Professor CAMPBELL.

42. [12.] Organic Preparations. Laboratory work. *Three to five hours.* Dr. GOMBERG.

Course 42 [12] must be preceded by Courses 5 [4] and 7 [10].

38. [32]. Organic Technology. The industrial chemistry of organic compounds. Among the subjects treated are: Starch, glucose, and sugar; fermentation and distillation; fats, oils and soaps; bleaching and dyeing; tanning; paper-manufacture. Lectures and assigned reading. *Five hours.* *M, Tu, W, Th, F,* at 11. Room B. Mr. WHITE.

Course 38 [32] must be preceded by Courses 7 [10] and 33 [31].

METALLURGY.

FIRST SEMESTER.

1. Fuel and Refractory Material, Iron and Steel. *Three hours.* *M, W, F,* at 9. Room B, Chemical Laboratory. Professor E. D, CAMPBELL.

Course 1 must be preceded by Course 3 in analytical chemistry, or by Course 1 in general chemistry.

2. Micro-Metallography. The study of the microscopic structure of metals as related to their physical and chemical properties. Laboratory work with reading. *One hour.* Professor E. D. CAMPBELL.

Course 2 can be taken only by those who have taken Course 1 in *metallurgy* and have received special permission.

ASTRONOMY.

FIRST SEMESTER.

4. Practical Astronomy. Use of sextant and transit. *Three hours. M, W, F,* at 10. Room 22, U. H., and Observatory. Professor HALL.

One-half of the class is instructed each semester.

5. Spherical Astronomy. *Three hours.* Room 22, U. H. Professor HALL.

In Course 5 some standard work on spherical astronomy is rapidly read, and special subjects are given out for discussion. Courses 5 and 9 follow Course 4, and are intended for students interested in geodetic work.

13. Theory of Least Squares. *Two hours.* Room 22, U. H. Professor HALL.

SECOND SEMESTER.

4. Practical Astronomy. *Three hours. Tu, W, Th,* at 10. Room 21, U. H., and Observatory. Professor HALL.
9. Practical Astronomy: extended course. *Hours and credit to be arranged.* Professor HALL.

MINERALOGY.

EITHER FIRST OR SECOND SEMESTER.

1. Short Course. Lectures and practice. *Two hours.* Lectures, *Tu, Th,* first semester at 9; second semester at 3. Practice, *twice a week, at hours arranged with instructor.* Room 6, T. H. Professor PETTEE.

For Course 1 some knowledge of chemistry is desirable.

GEOLOGY.

FIRST SEMESTER.

1. Elements of Geology. *Three hours. M, W, F,* at 3. Museum Lecture Room. Professor RUSSELL.

DRAWING.

FIRST SEMESTER.

1. Geometrical Drawing. *Two hours.* Room 9. Professor DENISON, Mr. GOULDING and Mr. GREEN.

Sec. I, *Tu, Th,* 8–10.
Sec. II, *Th,* 1–3, *S,* 10–12.
Sec. III, *Tu, Th,* 10–12.
Sec. IV, *M, W,* 1–3.
Sec. V, W, F, 8–10.

4. Free-Hand Drawing. Pen and Ink, Pencil-Work, Sketching. *Three hours.* Rooms 12 and 14.

Sec. I, *M, W, F,* 8–10. M. Goulding.

Sec. II, *M, W, F,* 8–10. Mr. Wrentmore.

Sec. III, *M, W, F,* 10–12. Mr. Wrentmore.

Sec. IV, *Tu, Th, S,* 8–10. Professor Denison and Miss Hunt

Sec. V, *M, W, F,* 1–3. Mr. Wrentmore.

Sec. VI, *Tu, Th,* 1–3; *S,* 10–12. Mr. ———.

Sec. VII, *M, W, F,* 10–12. Professor Denison and Mr. Goulding.

Sec. VIII, *M, W, F,* 1–3. Miss Hunt.

The number in each section is limited to *thirty.*

10. Continuation of Course 8. *Two hours. Tu, Th,* 10–12. Room 12. Professor Denison and Miss Hunt.

Course 10 must be preceded by Courses 4, 7 and 8. The number that can be accommodated is limited.

13. Water Color Drawing. *Three hours. Hours arranged with instructor.* Room 12. Professor Denison and Miss Hunt.

Course 13 must be preceded by Course 8. It is to be taken only by special permission.

SECOND SEMESTER.

5. Descriptive Geometry. *Four hours.*

Sec. I, *W,* at 3; *Th,* 1–3; *F,* at 3: *S,* at 8. Room 10. Mr. Goulding.

Sec. II, *M,* at 2; *Tu,* at 2–4; *F,* at 3; *S,* at 9. Room 3. Mr. Wrentmore.

Sec. III, *W,* 2–4: *Th, F,* at 2; *W,* at 8. Room 3. Mr. Wrentmore.

Sec. IV, *M,* 8–10; *W,* at 9; *Th,* at 8; *S,* at 9. Room 10. Mr. Goulding,

Sec. V, *M,* 1–3; *Tu, W,* at 2; *S,* at 10. Room 10. Mr. Goulding.

Sec. VI, *M, W, F,* at 1; *W,* 9–11. Room 3. Mr. Wrentmore,

4. Shades, Shadows, and Perspective. *Three hours. Hours to be arranged with instructor.* Room 10. Professor Denison.

Course 6 must be preceded by Course 5.

7. Free-Hand Drawing (advanced). *Three hours. M, W, F,* 10–12. Room 12. Professor Denison or Miss Hunt.

The number that can be accommodated is limited.

8. Architectural and Water Color Drawing. *Two hours.* Sec. I, *Tu, Th, 8–10; Sec II, Tu, Th,* 10–12. Room 12. Professor Denison, *Mr. Goulding,* and Miss Hunt.

Course 8 must be preceded by Course 1 or 4. The number that can be accommodated is limited.

14. Stereotomy. *Two hours.* Sec. I, *Tu, Th,* at 10; Sec. II, *Tu, Th,* at 11; *and such additional time as may be found necessary to complete the work.* Room 10. Professor DENISON.

Course 14 must be preceded by Course 5.

16. Free-Hand Lettering. *Two hours. Tu, Th,* 8–10. Room 14. Mr. WRENTMORE.

[This course will not be given during 1901–1902].

17. Spherical Projections. *One hour. Hour to be arranged with instructor.* Professor DENISON.

Course 17 must be preceded by Courses 1 and 5.

SHOP PRACTICE.

All Courses in Shop Practice are under the direction of the Superintendent. Lectures on materials and appliances used in shop-work will be given or reading will be assigned.

Courses *2a* and *3a* may also be continued by advanced students, and elected as *2b* and *3b*.

Fee for each course $5.00.

Special arrangements will be made for students who desire to take more advanced work in the shop courses with a view to preparing themselves for teaching these subjects.

FIRST SEMESTER.

1a. Carpentry. *Two hours.* One-half the class. Sec. I, *W,* 1–6; Sec. II, *F,* 1–6; Sec. III, *S.* 7:30–12:30; Sec. IV, *Tu,* 1–6; Sec. V, *Tu,* 9–12, *Th,* 10–12; Sec. VI, *M,* 9–12, *F,* 10–12. Mr. PURFIELD.

1b. Pattern Making. *Two hours.* Mechanicals. Sec. I, *M,* 1–6; Sec. II, *Th,* 1–6; Sec. III, *W,* 8–11, *F,* 8–10. Mr. PURFIELD.

2a. Blacksmithing. *Two hours.* One-half of class. Sec. I, *M;* Sec. II, *Tu;* Sec. III, *W;* Sec. IV, *Th;* Sec. V, *F.* All sections 1–5. Sec. VI, *S,* 8–12; Sec. VII, *Tu, Th,* 8–10; Sec. VIII, *W, F,* 8:10; Sec. IX, *M, F,* 10–12; Sec. X, *Tu, Th,* 10–12. Mr, McDONALD.

3a. Foundry. *Two hours.* One-half the class. Sec. I, *M;* Sec. II, *Tu;* Sec. III, *W;* Sec. IV, *Th;* Sec. V, *F.* All sections, 1–6. Mr. WINSLOW.

4a. Machine Shop. *Three hours.* One-half the class. Sec. I, *M, W,* 1–5:30; Sec. II, *Tu,* 1–5:30; *S,* 7:30–12; Sec. III, *Th, F,* 1–5:30; Sec. IV, *M, Th, F,* 8–11. Mr. COBB.

4b. Machine Shop (advanced). *Two hours.* Mechanicals. Sec. I, *Tu,* 8–12; Sec. II, *W,* 8–12. Mr. COBB.

SECOND SEMESTER.

1*a*. Carpentry. *Two hours.* One-half the class. Sec. I. *M;* Sec. II. *Tu;* Sec. III, *Th.* These sections 1–6. Sec. IV, *S,* 7:30–12:30; Sec. V, *M,* 8–11, *F,* 8–10; Sec. VI, *Tu,* 8–11, *Th,* 8–10. Mr. PURFIELD.

1*b*. Pattern Making. *Two hours.* Electricals. Sec. I, *W;* Sec, II, *F.* Each section 1–6. Sec. III, *W,* 9–12, *F,* 10–12. Mr. PURFIELD.

2*a*. Blacksmithing. *Two hours.* One-half the class. Sec. I, *M;* Sec, II, *Tu;* Sec. III, *W;* Sec. IV, *Th;* Sec. V, *F.* These sections, 1–5; Sec. VI, *Tu, Th,* 8–10; Sec. VII, *M,* 8–10; *F,* 10–12; Mr. MCDONALD.

3*a*. Foundry. *Two hours.* One-half the class. Sec. I, *Tu;* Sec. II, *W;* Sec. III, *Th.* These sections, 1–6; Sec. IV, *Tu,* 9–12, *Th,* 10–12. Mr. WINSLOW.

4*a*. Machine Shop. *Three hours.* One-half the class. Sec. I, *M, F,* 1–5:30; Sec. II, *Tu, Th,* 1–5:30; Sec. III, *Tu, Th,* 7:30–12. Mr. COBB.

4*b*. Machine Shop (advanced). *Two hours.* Electricals. Sec. I, *W,* 1–5:30; Sec. II, *S,* 7:30–12. Mr. COBB.

SURVEYING.

All the work in surveying is given in the Engineering Building.

FIRST SEMESTER.

1. Lectures, Text-book and Field Practice. *Five hours. M, Tu, W, Th, F,* 1–5. Room 5. Professor J. B. DAVIS.

The field practice in Course 1 continues during favorable weather until Christmas.

4. Use of Instruments. *One hour.* Mechanicals, *Tu,* 9–11; Chemicals, *W,* 10–12. Room 5. Professor J. B. DAVIS.

SECOND SEMESTER.

2. Continuation of Course 1. Lectures and text-book, *five hours. M, Tu, W, Th, F,* at 9. Room 5. Professor J. B. DAVIS.

Course 2 must be preceded by Course 1.

3. Field Work in Camp. *Six weeks, summer school, six days each week,* 8–12 *and* 1–5. Professor J. B. DAVIS.

Course 3 must be preceded by Courses 1 and 2.

Except by special permission, Course 3 is open only to students who are working for a degree in civil engineering. Students not working for a degree in civil engineering will be required to pay the regular summer school fee.

5. Topography. Transit and Stadia. Plane Table. Field work and Drawing. *Four hours. M, Tu, W, Th,* 1–5. Rooms 5. Professor J. B. DAVIS.

Course 5 requires neat and exact pencilling, accurate and smooth inking, plain lettering, good tracing, and paper and instruments in good working condition.

7. Geodesy. Geodetic Methods. Lectures and text-book, *four hours. M, Tu, W, Th,* at 8. Room 5. Professor J. B. DAVIS.

CIVIL ENGINEERING.

The work in civil engineering is conducted in the Engineering Building.

FIRST SEMESTER.

1. Municipal Engineering. Lectures and text-books. *Five hours. M, Tu, W, Th, F,* at 8. Room 5. Professor J. B. DAVIS.

4. Graphical Analysis of Structures. *Two hours. Tu, Th,* at 9. Room 4. Professor GREENE.

Course 4 must be preceded by Course 3.

6. Engineering. Theory of construction. *Two hours. M, F,* at 9. Room 4. Professor GREENE.

Course 6 must be preceded by Course 4 in mathematics.

7. Engineering Design. *Five hours. M, Tu, W, Th, F.* 1–4 or 2–5. Room 14. Professor GREENE, and Mr. F. M. GREEN.

Course 7 accompanies Course 6, and must be preceded by Course 5.

9. Hydraulics. *One hour. W,* at 9. Room 4. Professor GREENE.

Course 9 must be preceded by Course 6 in mathematics.

15. Highway Construction. *Two hours. Tu, Th,* at 10. Room 5. Professor J. B. DAVIS.

Primarily for Graduates.

11. Engineering Design (advanced). *Five hours.* Professor GREENE.
12. Water Supply and Sewerage. *Two hours,* Professor GREENE.

SECOND SEMESTER.

2. Tests of Materials. *One hour.* S, 9–12. Engineering Laboratory. Mr. F. M. GREEN.

3. Graphical Analysis of Structures. *Two hours.* Sec. I, *M*, *W*, at 10; Sec. II, *M*, *W*, at 11. Room 4. Mr. F. M. GREEN.

Sec. II is for students in civil engineering.

Course 3 must be preceded by Course 4 in mathematics.

5. Strength and Resistance of Materials. *Two hours.* *Tu*, *Th*, Sec. I, at 9; Sec. II, at 10. Room 4. Professor GREENE.

Course 5 must be preceded by Course 4 in mathematics.

8. Engineering. Theory of construction. *Three hours.* *M*, *W*, *F*, at 9. Room 4. Professor GREENE.

Course 8 must be preceded by Courses 3 and 6.

10. Water Supply and Sewerage. *Oue hour.* *F.* at 10. Room 4. Professor GREENE.

Course 10 follows course 9.

Primarily for Graduates.

13. Economics of Railway Location. *One hour.* Professor GREENE.
14. Contracts and Specifications. *One hour.* Professor J. B. DAVIS.

MECHANICAL ENGINEERING.

The work in mechanical engineering is conducted in the Engineering Building, unless otherwise noted.

FIRST SEMESTER.

2. Principles of Mechanism. *Two hours.* *M*, *F*, Sec. I, at 9; Sec, II, at 10 *and additional time arranged with instructor.* Room 10. Professor DENISON.

Course 2 must be preceded by Course 1 in mathematics, and by Courses 1 and 5 in drawing.

3. Dynamics of Machinery. *One hour.* Sec. I, *W*, at 9; Sec. II, *F*, at 8. Room 7. Mr. ANDERSON.

Course 3 must be preceded by Course 4 in mathematics, and by Course 1 in physics.

4. Boilers. Steam Engines. *Two hours.* *Tu*, *Th*, Sec. I, at 8; Sec. II, at 9. Room 7. Assistant Professor ALLEN.

Course 4 must be preceded or accompanied by Course 3.

8. Theory of Machine Design. *Three hours.* *W*, *Th*, *F*, at 11. Room 7. Professor COOLEY.

Course 8 must be preceded by Course 5 in civil engineering.

16. Heating and Ventilation. *Two hours.* *M*, *W*, at 8. Room 7. Assistant Professor ALLEN.

Course 16 must be preceded by Course 4.

Primarily for Graduates.

18. Hydraulic Machinery. *Two hours.* *W*, *F*, at 10. Room 7. Professor Cooley.

Course 18 must be preceded by Course 7 or 15.

19. Gas Engines. *Two hours.* *Tu*, *Th*, at 10. Room 7. Professor Cooley.

Course 19 must be preceded by Course 13.

20. Laboratory Work (advanced). *Two hours.* *Tu*, *Th*, 1–4, Engineering Laboratory. Assistant Professor Allen.

Course 20 must be preceded by Courses 9 and 11.

EITHER FIRST OR SECOND SEMESTER.

6. Machine Design. Machine tools. *Two hours.* *Tu*, *Th*, 1–4. Drawing Room, Engineering Shops. Superintendent Miggett.

Course 6 must be preceded by Courses 1, 4 and 5 in drawing, and preceded or accompanied by Course 2 in mechanical engineering.

9. Laboratory Work. Power measurements. Machine testing. *Two hours.* *Tu*, *Th*, 1–4. Engineering Laboratory. Professor Cooley, Assistant Professor Allen and Mr. Grimes. Fee, $5.

Course 9 must be preceded by Course 3.

It is suggested that Courses 9 and 10, and Courses 11 and 12, be taken in pairs.

10. Machine Design. Hoisting machinery. *Three hours.* *M*, *W*, *F*, 1–4. Engineering Laboratory. Professor Cooley and Mr. Anderson.

Course 10 must be preceded or accompanied by Course 8, and preceded by Course 6.

11. Laboratory Work. Steam engineering. *Three hours.* Sec. I, *M*, *F*, 1–5:30. Sec. II, *W*, 1–5:30; *S*, 8–12. Engineering Laboratory. Professor Cooley, Assistant Professor Allen, and Mr. Grimes. Fee, $5.

Course 11 must be preceded or accompanied by Courses 4 and 7, or 15.

12. Machine Design. Boilers and engines. *Two hours.* *Tu*, *Th*, 1–4. Engineering Laboratory. Professor Cooley and Mr. Anderson.

Course 12 must be preceded or accompanied by Course 8, and preceded by Course 6.

SECOND SEMESTER.

1. Elements of Machines. Nomenclature. *Two hours.* Sec. I, *M*, *F*, at 9. Room 10. Sec. II, *Tu*, *Th*, at 10. Room 11. Sec. III, *M*, *W*, at 11. Room 5. Mr. Anderson.

5. Mechanism. Valve Gears. *Three hours.* *Tu, Th, S,* Sec. I, at 10; Sec. II at 11. Room 3. Mr. WRENTMORE.

   Course 5 must be preceded by Course 2.

7. Hydraulic Machinery. *One hour.* Lecture, *W,* at 10; recitation, Sec. I, *F,* at 10; Sec. II, *W,* at 10. Room 7. Professor COOLEY.

   Course 7 must be preceded by Course 3.

13. Steam Engines and other heat engines. *Three hours.* *M, W, F,* Sec. I, at 8; Sec. II, at 9. Room 7. Assistant Professor ALLEN.

   Course 13 must be preceded by Course 4.

14. Power Plants. Power transmission. *Two hours.* *Tu, Th,* 10–12. *Four hours a week required in the class room.* Room 7. Professor COOLEY.

   Course 14 must be preceded by Courses 4 and 7.

15. Prime Movers. Water wheels and steam engines. *Two hours.* *M, W,* at 10. Room 7. Professor COOLEY.

Primarily for Graduates.

17. Compressed Air. Mechanical Refrigeration. *Two hours.* *Tu, Th,* at 9. Room 7. Professor COOLEY.

   Course 17 must be preceded by Course 13.

21. Specifications and Contracts. *One hour.* Professor COOLEY and Professor KNOWLTON.

   Course 21 must be preceded or accompanied by Course 14.

22. Thermodynamics. *Two hours.* *M, W,* at 11. Assistant Professor ALLEN.

   Course 22 must be preceded by Course 13.

23. Machine Design (advanced). *Three hours.* Mr. ANDERSON.

   Course 23 must be preceded by Courses 10 and 12.

ELECTRICAL ENGINEERING.

The courses in Electrical Engineering are given in the Physical Laboratory.

FIRST SEMESTER.

2. Electrical Measurements. *Four hours.* Recitations, *W, F,* at 2. Professor CARHART. Laboratory work, *two forenoons, two hours each.* Professor CARHART and Assistant Professor GUTHE. Fee, $2.

   Course 2 must be preceded by Courses 1, 2 and 3 in physics; a *knowledge of* calculus is also required.

5. Alternating Current Apparatus. *Three hours.* Recitations, *Tu, Th*, at 8. Laboratory work, Sec. I, *M*, 2–4; Sec. II. *W*, 2–4. Professor PATTERSON and Mr. ———. Fee, $1.

Course 5 must be preceded by Course 4.

6. Photometry of Electric Lamps. *One hour.* Recitations, *F*, at 8, for first eight weeks; laboratory work *once a week* for last eight weeks; *hours to be arranged with instructor.* Mr. ———. Fee, $1.

7. Design of Electrical Machinery. *Four hours.* Lectures, *M, W*, at 8. Drawing, *Tu, F*, 1–5. Professor CARHART and Mr. ———.

Course 7 must be preceded by Course 4.

SECOND SEMESTER.

1. Primary and Secondary Batteries. *Two hours.* Recitations, *M* at 9. Laboratory work, Sec. I, *M*, 10–12; Sec. II, *Tu*, 10–12; Sec. III. *Th*, 8–10; Sec. IV, *Th*, 10–12; Sec. V, *S*, 8–10; Sec. VI, *S*, 10–12, Assistant Professor GUTHE and Mr. ———.

Course 1 must be preceded by Courses 1, 2 and 3 in physics, and a course in general or analytical chemistry.

3. Electrical Measurements: continuation of Course 2. *Three hours.* Laboratory work, *M, W, F, forenoon.* Assistant Professor GUTHE and Mr. ———. Fee, $2.

4*a*. Dynamo-Electric Machinery. *Four hours.* Lectures and recitations, *Tu, Th*, at 8. Professor PATTERSON. Laboratory work, *Tu, Th*, 2–4. Professor PATTERSON and Mr. ———. Fee, $2.

4*b*. Dynamo-Electric Machinery. *Three hours.* Recitations and lectures as above. Laboratory work, Sec. I, *W*, 1–3; Sec. II, *F*, 1–3; Sec. III, *F*, 3-5. Fee, $1.

Course 4*a* must be preceded by Course 2 in electrical engineering, and 4*b* by Course 3*c* in physics.

8. Distribution of Electricity. *Two hours.* *W, F*, at 8. Lectures and recitations. Mr. ———.

Course 8 must be preceded by Course 4.

10. Design of Electrical Machinery: continuation of Course 7. *Two hours.* *W, F*, 1-5. Room 9. Professor CARHART and Mr. ———.

11. Telephone and Telegraph. *Two hours.* Professor PATTERSON.

Course 11 must be preceded by Course 4*a* or 4*b*.

Primarily for Graduates.

9. Alternating Current Phenomena: Steinmetz. *Two hours.* Professor PATTERSON.

Course 9 must be preceded by Course 5.

NAVAL ARCHITECTURE AND MARINE ENGINEERING.

The work in Naval Architecture and Marine Engineering is conducted in the Engineering building unless otherwise stated.

FIRST SEMESTER.

1. Naval Architecture. Ship Calculations. *Three hours. M, W, F,* at 10. Room 11. Professor SADLER.

Course 1 is designed for graduates or undergraduates who have had the necessary training.

2. Naval Architecture. Drawing. *Two hours. M, Th,* 9-12. Engineering Laboratory. Professor SADLER.

Course 2 must be accompanied by Course 1.

3. Marine Engines. *Three hours. M, Tu, Th,* at 9. Room 11. Professor SADLER.

Course 3 is designed for graduates or for undergraduates who have had the necessary training.

4. Naval Architecture. Strength, Stability and Ship Design. *Two hours. W, F,* at 9. Room 11. Professor SADLER.

6. Naval Architecture. Drawing. *Five hours. M, Tu, W, Th, F,* 1-4. Engineering Laboratory. Professor SADLER.

Course 6 must be accompanied by Course 4.

SECOND SEMESTER.

1. Naval Architecture. Ship Calculations. *Three hours. M, W, F,* at 10. Room 11. Professor SADLER.

Course 1 is designed for graduates or for undergraduates who have had the necessary training.

2. Naval Architecture. Drawing. *Two hours. M, F,* 1-4. Engineering Laboratory. Professor SADLER.

Course 2 must be accompanied by Course 1.

5. Marine Engines. *Two hours. Tu, Th,* at 10. Room —. Professor SADLER.

7. Naval Architecture. Stability and Resistance. *Five hours. M, Tu, W, Th, F,* at 9. Room 11. Professor SADLER.

Course 7 must be preceded by Course 4.

8. Naval Architecture. Drawing. *Three hours. M, W, F,* 1-4 Engineering Laboratory. Professor SADLER.

Course 8 must be accompanied by Course 7.

9. Marine Engines. Drawing. *Two hours. Tu, Th,* 1-4. Engineering Laboratory. Professor SADLER.

10. Naval Architecture. Advanced Reading. *Three* hours. Hours to *be arranged with instructor.* Professor SADLER.

UNIVERSITY BULLETIN
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January 1, 1902.

UNIVERSITY OF MICHIGAN

DEPARTMENT OF ENGINEERING

GENERAL ANNOUNCEMENT

1902 - 1903

ANN ARBOR, MICH.
PUBLISHED BY THE UNIVERSITY
1902

UNIVERSITY OF MICHIGAN

DEPARTMENT OF ENGINEERING

GENERAL ANNOUNCEMENT

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CALENDAR.

1902.	
Feb. 7–8.	Examination for Admission.
Feb. 10.	Second Semester Begins.
April 11.	(Evening.) Recess begins, ending April 21 (evening).
June 17.	Class Day.
June 18.	Alumni Day.
June 19.	Commencement in All Departments.
June 20 to Sept. 22.	Summer Vacation. Summer School for six weeks, beginning soon after Commencement.
Sept. 17 to 20.	*Examination for admission to the Department of Engineering.*
Sept. 23.	First Semester Begins in All Departments.
Nov. —	Thanksgiving Recess of three days, beginning Tuesday evening.
Dec. 19.	(Evening.) Holiday Vacation begins.
1903.	
Jan. 6.	Exercises resumed after Holiday Vacation.
Feb. 6.	(Evening.) First Semester Closes.
Feb. 6–7.	Examination for Admission.
Feb. 9.	Second Semester Begins.
April 10.	(Evening.) Recess begins, ending April 20 (evening).
June 18.	Commencement in All Departments.

Department of Engineering.

FACULTY.*

JAMES B. ANGELL, LL.D., President.

ALBERT B. PRESCOTT, M.D., LL.D., Director of the Chemical Laboratory, Professor of Organic Chemistry, and Dean of the School of Pharmacy.

CHARLES E. GREENE, A.M., C.E., Professor of Civil Engineering and Dean of the Department of Engineering.

WILLIAM H. PETTEE, A.M., Professor of Mineralogy, Economic Geology and Mining Engineering.

MORTIMER E. COOLEY, M.E., Professor of Mechanical Engineering.

CHARLES S. DENISON, M.S., C.E., Professor of Stereotomy, Mechanism, and Drawing.

HENRY S. CARHART, LL.D., Professor of Physics and Director of the Physical Laboratory.

RAYMOND C. DAVIS, A.M., Librarian.

OTIS C. JOHNSON, Ph. C., A.M., Professor of Applied Chemistry.

JOSEPH B. DAVIS, C.E., Professor of Geodesy and Surveying.

ASAPH HALL, Jr., Ph.D., Professor of Astronomy and Director of the Observatory.

ISRAEL C. RUSSELL, C.E., LL.D., Professor of Geology.

ARTHUR G. CANFIELD, A.M., Professor of Romance Languages.

MAX WINKLER, Ph.D., Acting Professor of German.

EDWARD D. CAMPBELL, B.S., Junior Professor of Analytical Chemistry.

ALEXANDER ZIWET, C.E., Junior Professor of Mathematics. (In charge of Engineering Mathematics.)

GEORGE W. PATTERSON, Jr., Ph.D., Junior Professor of Electrical Engineering.

JOHN O. REED, Ph.D., Junior Professor of Physics.

HERBERT C. SADLER, B.S., Junior Professor of Naval Architecture.

KEENE FITZPATRICK, Director of the Waterman Gymnasium.

JOSEPH L. MARKLEY, Ph.D., Assistant Professor of Mathematics.

**In this list are included a few other officers and instructors with whom engineering students may have occasion to confer.*

MOSES GOMBERG, Sc.D., Assistant Professor of Organic Chemistry.

JOHN R. ALLEN, M.E., Assistant Professor of Mechanical Engineering.

KARL E. GUTHE, PH.D., Assistant Professor of Physics.

WILLIAM L. MIGGETT, B.S., Superintendent of Engineering Shops.

CLARENCE G. WRENTMORE, M.S., Instructor in Descriptive Geometry and Drawing.

ARTHUR G. HALL, B.S., Instructor in Mathematics.

WILLIAM H. WAIT, PH.D., Instructor in German.

BENJAMIN F. BAILEY, B.S., A.M., Instructor in Electrical Engineering.

JAMES W. GLOVER, PH.D., Instructor in Mathematics.

HERBERT J. GOULDING, B.S., Instructor in Descriptive Geometry and Drawing, and Secretary of the Department of Engineering.

ALFRED H. WHITE, A.B., Instructor in Chemical Technology.

WILLIAM H. BUTTS, A.M., Instructor in Mathematics.

EUGENE C. SULLIVAN, PH.D., Instructor in Analytical Chemistry.

HENRY C. ANDERSON, M.E., Instructor in Mechanical Engineering.

ALICE L. HUNT, Instructor in Drawing.

EDWARD B. ESCOTT, M.S., Instructor in Mathematics.

WILLIAM MARSHALL, M.S., Instructor in Mathematics.

CARL F. A. LANGE, A.M., Instructor in German.

FRED M. GREEN, B.S., Instructor in Civil Engineering.

WALTER B. FORD, A.M., Instructor in Mathematics.

COLMAN D. FRANK, PH.B., Instructor in French and Spanish.

HARRISON M. RANDALL, PH.M., Instructor in Physics.

ROYAL A. ABBOTT, PH.B., Instructor in English.

*HOMER J. PARKER, M.E., Instructor in Mechanical Engineering.

J. CHARLES THORPE, B.S., Instructor in Mechanical Engineering.

HARRY J. SPROAT, B.S., Assistant in Astronomy.

ROSCOE B. JACKSON, Assistant to the Dean of the Department.

LINDLEY PYLE, A.B., Assistant in Physics.

CHARLES S. SHELDON, Assistant in Mechanical Drawing.

MARKHAM CHEEVER, Assistant to the Superintendent of Engineering Shops.

SPECIAL ASSISTANTS IN THE ENGINEERING SHOPS.

ROBERT A. WINSLOW, Foundry.

HARRY M. COBB, Machine Room.

HORACE T. PURFIELD, Carpentry and Pattern Room.

IAM R. McDONALD, Blacksmith Shop.

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Department of Engineering.

GENERAL INFORMATION.

The University of Michigan is a part of the educational system of the State, and derives from the State, in one way or another, the greater part of its revenue. The University comprises the Department of Literature, Science, and the Arts, and six professional schools, each of which has its own Faculty and issues each year a separate departmental announcement. The various Faculties include more than one hundred and fifty officers of instruction, besides numerous assistants, some of whom participate in the work of teaching. Thirty-five hundred students, representing all the States and Territories, and many foreign countries, are in attendance.

In the legislative act under which the University was organized in 1837, provision was made for instruction in engineering. There are few older technical schools in the United States. Work was begun in this line in 1853, and the first degrees were conferred in 1860. The engineering courses were included in the Department of Literature, Science, and the Arts, until the close of the collegiate year 1894–95. At that time the Department of Engineering was established by the Board of Regents.

Persons who wish to become professional engineers are offered here thorough courses of study in civil, mechanical, electrical, chemical, and marine engineering, and naval architecture. The work extends through four years, and leads to the degree of Bachelor of Science. The degrees of M.S., C.E., M.E., and E.E. are given for postgraduate work. The aim of the department is to lay a foundation of sound thory, sufficiently broad and deep to enable its graduates to enter understandingly on the further investigation of the several specialties of the engineering profession; and at the same time to impart such a knowledge of the usual professional practice as shall make its students useful in any position to which they may be called. While the adaptation of theory to practice can be thoroughly learned only by experience, there are many matters in which the routine work of an engineering field party, office, or drafting room can be carried out on a greater or less scale in a training school. *The technical branches are under the direct care of those who have had professional experience as well as a full scientific training.* The instructors who have the several branches in charge aim to fit the students, as far as possible, for the requirements of active practice.

The work for the first year is the same for all students. At the end of the first year the student makes his choice to continue in the civil engineering, the mechanical engineering, the electrical engineering, or the chemical engineering course. At a later date he may choose, if he prefers, the work in marine engineering. The Order of Studies, given on pages 49 to 52, is the one recommended by the Department; and the days and hours assigned to the different exercises each year in the Special Program are planned to avoid conflicts. A student can, however, deviate from this printed order, if his preparation for a given study meets the requirements prescribed by the instructor, and if he assumes all risk of interference of hours in subsequent semesters.

No marked distinction between first year, second year, etc., is made; but a student is recommended for a particular degree when he has successfully completed the requirements for the same, as laid down on pages 54 to 56.

The academic year extends from the Tuesday preceding the last Wednesday in September to the Thursday preceding [illegible] last Wednesday in June (September 23, 1902, to June

The Department of Engineering considers that the merits of the course of study and work prescribed for its students can be judged fairly by the professional success of its graduates. Copies of a Register of Alumni, classes 1860 to 1898 inclusive, published in 1899, and showing positions held since graduation, can be obtained on application until the edition is exhausted. The classes of 1899 and 1900 were given in the Announcement for 1901–02, now out of print.

REQUIREMENTS FOR ADMISSION TO THE DEPARTMENT OF ENGINEERING.

[For admission to advanced standing, see page 11.]

[For admission of students not candidates for a degree, see page 13.]

Candidates for admission must be at least sixteen years of age, and must present satisfactory evidence of good moral character. They must bring credentials from their last instructor, or from the last institution with which they have been connected.

Unless admitted on diploma from an approved school (see page 14), any student who desires to become a candidate for a degree must pass examinations in the subjects described below. Before entering upon the examination each applicant must present his credentials to the Dean of the Department at his office in the Engineering Building.

Certificates and diplomas from schools other than those officially examined and approved by the University, as specified on page 14, will not excuse applicants from admission examinations.

Students who have satisfied the requirements for admission to the Department of Literature, Science, and the Arts are admitted to this department, but must make up their deficiencies in *plane trigonometry* and *science,* if such deficiencies exist.

All entrance conditions must be removed by the beginning *of the second year* of residence.

ADMISSION OF CANDIDATES FOR A DEGREE.

The subjects on which applicants for admission to any of the courses leading to a degree in engineering will be examined are as follows:

English Language. — *Grammar.* — The requirement is intended to cover three years' work. Selections for analysis and parsing will be set, arranged to test the applicant's knowledge of the leading facts of English Grammar. To meet this requirement, a review of the subject should be had during the last year of the preparatory course.

Composition and Rhetoric. — The purpose of the examination in composition is to test the applicant's ability to write good English. To this end he will be asked to write two essays of not less than two hundred words each, one upon a subject drawn from the books mentioned below, and the other upon a subject drawn from his experience or observation. The language of these essays must be grammatical and clear. The spelling, punctuation, and capitalizing must be correct. The applicant must show ability to discriminate in the use of words, and to construct well-organized sentences and paragraphs. A topical outline should accompany each essay.

As preparation for this requirement, sustained and regular practice in writing is earnestly recommended. The student should prepare numerous written exercises throughout the four years of the high school course, and a sufficient number of these exercises should be corrected by the teacher and revised by the student to secure the desired accuracy. The subjects upon which the student writes should not be drawn exclusively from literature; a considerable proportion of them should be taken from the student's every day experience; and topics should be so distributed as to give proper training in the various types of discourse, namely, description, narrative, argument, and exposition. The student should be grounded in the essentials of rhetoric, but those principles should receive emphasis which are most likely to be of service to him in his practice in writing, such as the principles of sentential structure, paragraphing, and the outlining of the essay. The correction of stock specimens of bad English is not recommended, and will form no part of the entrance requirement.

The titles of the books from which subjects for compositions will be chosen in the years named, are here given. The applicant [illegible]ould make himself familiar with the plot, incidents, and charac[illegible]f each work. Equivalents will be accepted.

[illegible] Shakespeare's *Merchant of Venice* and *Macbeth*; Milton's *L'Allegro*, and *Il Penseroso*; Burke's Conciliation *with the Colonies;* Macaulay's *Essays on Milton and Addison;* Pope's *Iliad,* Books I, VI, XXII, and XXIV; The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Coleridge's *The Ancient Mariner;* Scott's *Ivanhoe;* Cooper's *The Last of the Mohicans;* Tennyson's *The Princess;* Lowell's *The Vision of Sir Launfal;* George Eliot's *Silas Marner.*

1903, 1904, and 1905. Shakespeare's *Merchant of Venice, Julius Caesar,* and *Macbeth;* Milton's *Lycidas, Comus, L'Allegro,* and *Il Penseroso;* Burke's *Conciliation with the Colonies;* Macaulay's *Essays on Milton and Addison;* The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Coleridge's *The Ancient Mariner;* Scott's *Ivanhoe;* Carlyle's *Essay on Burns;* Tennyson's *The Princess;* Lowell's *The Vision of Sir Launfal;* George Eliot's *Silas Marner.*

Reading of Classics.— In addition to the books just named, it is expected that several other English Classics will be read each year. These readings should be connected, in reasonable measure, with the lives and characters of the authors read and with the history of their times. A good knowledge of the chronological order and of the leading characteristics of the leading modern English writers should be aimed at. Care should be taken not to overload the text of these classics with a mass of irrelevant and petty learning. Many of the "school classics" now in use are over-edited.

It is further recommended that the reading of English classics and the memorizing of notable passages, both in prose and poetry, should form a regular exercise throughout the whole preparatory period. This is all-important for the development of a correct taste in language and literature.

English Literature.— The requirement is intended to cover one year's work. Stopford A. Brooke's English Literature (edition of 1896), or any other manual, may be used for an outline of the subject. As much time as practicable should be given to the careful reading of representative authors in each period.

Mathematics.* — *Algebra.*— Fundamental Rules, Fractions, Simple Equations, Involution and Evolution, the Theory of Indices, and Quadratic Equations, as given in Beman and Smith's Elements of Algebra, or an equivalent in other authors.

Geometry.— Plane, Solid, and Spherical Geometry as given in Beman and Smith's Plane and Solid Geometry, or an equivalent in other authors.

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* Students entering at the beginning of the second semester (February 10, 1902) *should be prepared in the* mathematics of the first semester in addition to the other *requirements for admission.*

Trigonometry.— Plane Trigonometry as given in Murray's or Wentworth's Trigonometry, or an equivalent in other authors.

N. B.— It is very desirable that High Schools whose graduates are received on diploma arrange their courses so as to include a portion of both Algebra and Geometry in their last preparatory year. Students who do not come from diploma schools should take a similar review if they expect to succeed in the study of mathematics in the University.

French, German, or Latin.— Applicants may offer French, German, or Latin, one of these three languages being required. It is expected that at least two years will be given to preparation in the language offered. The requirements in each are as follows: —

French.— The whole subject of French Grammar. The applicant will be expected to read at sight easy French, and to translate correctly into French simple English sentences. The first year ought to be spent chiefly on the grammar and easy reading; and the second devoted to reading good modern French, accompanied by grammatical analysis and exercises in writing. The texts read should be chiefly narrative and conversational prose; modern, rather than classic, dramas, should be read.

German.— The applicant should be able to pronounce German correctly and to take part with reasonable correctness and facility in a simple conversation upon some topic drawn from the applicant's preparatory work. He should also be thoroughly familiar with the everyday facts of the grammar, to be evinced by putting illustrative English phrases into German, and be able to translate at sight a passage of fairly easy prose.

Latin.— Jones's First Latin Book, or an equivalent amount in any other introductory text-book, four books of Cæsar's Gallic War, and one of the orations of Cicero.

Advanced credit may be secured for one or two years of German or French study in excess of the two years required for admission; and also if Latin and German or Latin and French are offered, advanced credit is given for the modern language, one year's study being deemed equivalent to Course A, and a second year's study to Course B (page 38).

Physics.— An amount represented by Carhart and Chute's Elements of Physics, to which one year should be devoted. Laboratory work in Physics is earnestly advised, though not required; but students who have completed a course in laboratory practice may expect to derive advantage from it if they take work in the physical laboratory in the University (see page 40).

Chemistry.- The requirement is intended to cover one year's work. · *text-book*, Freer's Elementary Chemistry, or an equivalent amount of work in Remsen's Introduction to the Study of Chemistry, is recommended. In either case the text should be accompanied by laboratory work.

History.— One year's work in General History as presented in such a work as Myers' General History, or one year's work in Mediæval and Modern History, and one year's work in United States History and Government, two years in all. Johnston's History of the United States, McLaughlin's History of the American Nation, Adam's European History, Coman and Kendall's History of England, Larned's History of England are suggested.

Botany, Physical Geography, or Astronomy.— The applicant may offer any *one* of these subjects. The requirements, intended to cover a half-year's work in each subject, are as follows: —

Botany.— Laboratory work for half a year with occasional recitations and review exercises. The method followed in Spalding's Introduction to Botany, or other modern text-book of similar plan and scope, may serve to indicate the kind of work desired.

Physical Geography.— Tarr's Elementary Physical Geography or an equivalent.

Astronomy.— Newcomb and Holden's Astronomy, Briefer Course, Young's Elements of Astronomy, or an equivalent. A knowledge of the principal constellations is required.

ADMISSION TO ADVANCED STANDING

1. Graduates of the Department of Literature, Science, and the Arts of this University, or of any other reputable college, are admitted without examination to advanced standing as candidates for a degree in engineering, and are excused from a considerable portion of the general requirements (see page 54). The remaining requirements can be completed in two years, if the student takes as electives, while an undergraduate,* the mathematics required of engineering students (see page 39) and Courses 1, 4, and 5 in drawing (see page 43). A knowledge of differential and integral calculus, of analytical mechanics, of elementary drawing, and of descriptive geometry, is needful for the advanced work.

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*A student enrolled in the Department of Literature, Science, and the Arts, and desiring to elect any work in the Department of Engineering which is not printed in the *Announcement of the former* Department, must obtain written permission [illegible] *own Dean, have it approved* by the Dean of the Department of Engineering, [illegible] *tach that paper to his* election slip.

2. Students who have completed at least one year's college work in an approved college, and who bring explicit and official certificates describing their course of study and scholarship, and testifying to their good character, are admitted to advanced standing without examination, except such as may be necessary to determine what credit they are to receive for work done in the college from which they have come.

3. Students who have not completed a year's college work in an approved college, but previously to entering this department of the University have pursued studies beyond those required for admission, may be admitted to advanced standing on passing the regular entrance examinations, and examinations in such undergraduate studies as they may ask to be credited with in advance.

Students entering at the beginning of the second semester, February 10, 1902, and expecting to join the first year's class, should be prepared in the mathematics of the first semester, mathematics 1, advanced algebra and analytic geometry (page 39), in addition to the other requirements for admission.

4. Rules Relating to Admission to Advanced Standing.

a. Any student, whether a candidate for a degree or not, who applies for advanced standing on the conditions stated in paragraphs (2) and (3) above, must present to the Dean a statement showing the amount of work done in the subjects in which credit is asked.

b. The application for advanced standing should be made to the Dean upon entering the Department. The Dean will then furnish a blank form for presentation to the professors in charge of the several subjects named in the blank, and each professor will indicate on the sheet the amount of credit in his subject to which the applicant is entitled.

c. Credits must be secured before November 1 or (if the student be matriculated at the beginning of the second semester) before March 15.

d. No credit will be given for advanced standing after dates named in (*c*).

e. An account once closed cannot be reopened without special permission of the Faculty.

ADMISSION OF STUDENTS NOT CANDIDATES FOR A DEGREE.

All applicants under twenty-one years of age must pass the regular entrance examinations, or bring the graduation certificates described on page 14; hence they will, on admission, be enrolled as regular students.

However, to afford an opportunity for persons of mature age, practicing engineers, teachers or others, to take up a few subjects offered in the Department, and to reside at the University a limited time, without becoming regular students, it is provided that persons over twenty-one years of age who desire to pursue studies in this department, and do not desire to become candidates for a degree, may be admitted on the following conditions:

1. They must show that they have a good knowledge of English, and are otherwise prepared to pursue profitably the studies they may desire to take up. Every applicant ought to have the training received in a good high school; and a knowledge of algebra, geometry, trigonometry, physics, and chemistry, equivalent, at least, to that prescribed in the requirements for admission, will be necessary.

2. Should a student who enters under the preceding provision (1) subsequently become a candidate for graduation, he must pass the regular entrance examination, at least one year previous to the time when he proposes to graduate.

3. Students not candidates for a degree who wish credit for studies pursued before admission are referred to the rules relating to advanced standing given above.

4. Students not candidates for a degree are expected to attend the lectures, recitations, and examinations in the branches prescribed for the regular students, and are required to take enough work to occupy them profitably.

EXAMINATIONS FOR ADMISSION.

The principal examination for admission to the *Department of Engineering* will be held on Wednesday, Thursday, Friday, and Saturday, September 17–20, 1902. Another opportunity is afforded on February 6–7, 1903; but entrance in September is strongly advised. Applicants will not be examined at any other time except on payment of a special fee of *five dollars.*

As the examination begins at 10 A. M. on Wednesday, it will be necessary for all applicants for admission on examination to present their credentials to the Dean of the Department, at his office, on Tuesday or Wednesday, September 16 or 17, between the hours of 9 and 5, and receive from him papers admitting to the examination.

The examinations in the several subjects will be in writing, and will be held in Tappan Hall in accordance with the schedule given below.

SCHEDULE OF EXAMINATIONS FOR ADMISSION IN 1902.

	Sept. 17, Wed.	Sept. 18, Thu.	Sept. 19, Fri.	Sept. 20. Sat.	
Botany	10 A. M.	......	......	......	Room 8
History	2 P. M.	......	......	......	Room 8
Geometry	......	8 A. M.	......	......	Room 8
French	......	10 A. M.	......	......	Room 12
German	......	2 P. M.	2 P. M.	......	Room 10
Latin	......	2 P. M.	2 P. M.	......	Room 8
Chemistry	......	4 P. M.	......	......	Room 8
Algebra	......	......	8 A. M.	......	Room 8
English Lit.	......	......	10 A. M.	......	Room 10
Physics	......	......	......	8 A. M.	Room 8
English	......	......	......	10 A. M.	Room 10
Phys. Geo. & Ast.	......	......	......	2 P. M.	Room 8
Trigonometry	......	......	......	4 P. M.	Room 8

ADMISSION ON DIPLOMA.

Students presenting graduation certificates from any of the schools officially approved by the Faculty of the Department of Literature, Science, and the Arts, signed by the superintendent or the principal of the school, are admitted without examination to the Department of Engineering. But if such certificate, though it might admit a student to the Department of Literature, Science, and the Arts, shows any deficiencies in the requirements for admission to the Department of Engineering, as for example, plane trigonometry or chemistry, such deficiencies must be made up, or substitutions secured from the Dean; extra studies may be credited on advanced standing, if the subjects are taught in either of the two departments.

The certificate must state that the student has sustained his examinations in all the studies prescribed for admission to the Department of Engineering, or for the fifteen units of credit prescribed for admission to the Department of Literature, Science, and the Arts, and is recommended for admission to the University. It must be presented to the Dean of the Department within a year and three months after graduation from the school, and the student must then begin his work.

FEES AND EXPENSES.

Matriculation Fee.— Every student before entering any department of the University is required to pay a matriculation fee. This fee, which, for citizens of Michigan, is ten dollars, and for those who come from any other State or country, twenty-five dollars, is paid but once, and entitles the student to the privileges of permanent membership in the University.

Annual Fee.— In addition to the matriculation fee, every student has to pay an annual fee for incidental expenses. This fee is paid the first year of residence at the University, and every year of residence thereafter. Resident graduates are required to pay the same annual fee as undergraduates. The annual fee in the Department of Engineering is, for Michigan students, thirty-five dollars; for all others, forty-five dollars.*

The Matriculation Fee and the Annual Fee must be paid *in advance.* No portion of the fees can be refunded, except by order of the Board of Regents, to students who leave the University during the academic year. A by-law of the Board of Regents provides that no student or graduate shall be allowed to enjoy the privileges of the University until he has paid all fees that are due.

Fee for Special Entrance Examinations.— An applicant for admission who desires to take the entrance examination at a time not announced is required to pay to the Treasurer a fee of five dollars before permission to take the examination can be granted him.

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*An annual fee of ten dollars is required of all graduates who are granted the privilege of pursuing studies for an advanced degree *in absentia.*

Diploma Fee.— The fee for the diploma given on graduation is ten dollars, and the by-laws of the Board of Regents prescribe that no person shall be recommended for a degree until he has paid all dues, including the fee for diploma.

Laboratory Courses.— The required laboratory courses cost approximately as follows: *Shop' Practice.*— In the mechanical and electrical engineering courses, *thirty dollars;* in the civil engineering course, *ten dollars.* *Physical Laboratory.*— A charge of *one dollar* is made for a course requiring one exercise a week during one semester, and at the same rate for the longer courses. *Mechanical Laboratory.*— The charge for each course is *five dollars.* *Chemical Laboratory.*— Students who take laboratory courses in chemistry are required to pay for the materials and apparatus consumed by them. The average cost is about *ten dollars.*

The fee required for any course has to be paid before the work of the course is begun.

The total amount of fees paid to the University during the whole four years' course. for matriculation, incidental expenses, materials used, and diploma, is, for Michigan students, from $185 to $210; and for others, from $240 to $265, varying more or less according to the student's actual laboratory expenses.

OTHER EXPENSES.— There are no dormitories and no commons connected with the University. Students obtain board and lodging in private families. Room rent varies from seventy-five cents to two dollars a week for each student. Board varies from two dollars and a quarter to three dollars per week. Clubs are also formed in which the cost of board is somewhat reduced.

Students on arriving in Ann Arbor can obtain information in regard to rooms and board by calling at the office of the Secretary of the University. The Students' Christian Association and the University Y. M. C. A. also actively interest themselves in assisting newcomers to find rooms and boarding places. The University does not undertake to furnish manual labor to students; yet a few find opportunities in the city to meet a portion of their expenses. The student organizations mentioned above do what they can to aid those who are seeking employment.

There are no scholarships, at present, in the Department of Engineering.

The annual expenses of students, including clothing and incidentals, are, *on the average,* about three hundred and seventy dollars. By the practice of economy, it is possible to complete the four years for one thousand dollars. Not a few students are enabled to complete their course by withdrawing for a year or two to earn money to carry them through the remaining years.

The following actual case is given of the expenses of a Michigan student in his first year:

Matriculation fee	$10 00
Annual fee	35 00
Shop-work fees, one course each semester	10 00
Drawing instruments	20 00
Books and stationery	25 00
Room and laundry, at $1.50 per week (might have been reduced by sharing room with another),	55 00
Board, 34 weeks, at $2.50	85 00
Clothes and incidentals	30 00
	$270 00

The matriculation fee is paid but once; the drawing instruments, if well selected, will be serviceable for a long time; railroad fares will vary, and are not included.

The annual expenses at the University with ordinary economy, may be put at from $250 to $300.

RELATION OF STUDENTS TO THE CIVIL AUTHORITIES.

Students are temporary residents of the city, and, like all other residents, are amenable to the laws. If guilty of disorder or crime, they are liable to arrest, fine, and imprisonment. A rule of the University Senate provides that if a student is arrested, or is convicted by the civil authorities, he shall be cited to appear before the Faculty of the department in which he is matriculated, and shall be liable to suspension or expulsion.

THE WORK OF THE DEPARTMENT.

The studies pursued in the earlier part of the course comprise, in *Mathematics,* advanced algebra, analytic geometry, and the elements of differential and integral calculus; in *French* and *German,* an amount covering in all about a year and a half of study; in *English,* courses in higher English grammar and composition; in *Physics* and *Chemistry,* studies of the principles; in *Drawing,* practice in geometrical and in mechanical drawing, and in the study of descriptive

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In *Carpentry and Pattern Making*, after the student has completed the preliminary series of graded exercises, he is set to making and assembling the parts of some complete piece of carpenter or joiner work, and he then devotes the remainder of the time, about three fifths of the whole, to the pattern work. Special stress is laid upon this part of the course. The student shapes, forms, and builds up patterns for castings in iron, brass, etc.: allows for shrinkage; makes core boxes; and becomes as familiar as possible, in the time allowed, with all the details of practice. Each class, with the help of the instructors, is expected to make a full set of the patterns needed for the construction of some special piece of working machinery.

In the *Foundry* the student learns to mould in green sand, in dry sand, and in loam, both for brass and for iron castings. Instruction is given in the making of cores for various purposes, and their use in the moulds; and in the art of selecting and mixing metals so as to produce the kind of material desired, careful attention being paid to the making of composition metals for specific purposes. Each student is required to take part in all of the work about the cupola and the brass furnaces, and to assume his share of their management during the periods of melting and casting.

In the *Blacksmith Shop* the student is required to make forgings from a large variety of irons and steels. In this way he becomes familiar with different kinds and qualities of materials suited for blacksmith work; he learns how to heat, forge, anneal, harden, and temper such tools as are used in machine shops; and he also has practice in soldering and brazing. The object of the course is to enable the student to acquire a certain degree of skill in practice, and at the same time impart to him a knowledge of the principles governing such processes of forging as an engineer is likely to be called upon to direct.

In the *Machine Shop* the instruction is conducted on the same plan as in the pattern shop. On the completion of the series of graded exercises, the student begins the construction of parts of machines. Each class undertakes the building of one or more simple machines, or pieces of apparatus; and the work is planned in such a way as to give opportunity for learning general shop manipulation. Advanced students are also allowed to elect extra work and to assist the skilled workmen in the construction of larger machines.

A description of the engineering shops is given on page 31.

Manual Training. — In all the above-described courses advanced work can be taken by students who wish to become specially skilled in certain lines, or who desire to fit themselves for instructors in Manual Training Schools or in shops of that character.

Chemistry. — The course in the principles of chemistry, for all students of engineering, consists of lectures, with demonstrations and recitations. It covers briefly the facts regarding the metallic and non-metallic elements, and some attention is given to the method of scientific reasoning. Recent work in electro-chemistry is also touched upon. The students are prepared in this course to take up later the chemical processes involved in metallurgy.

Drawing. — A very complete course in mechanical drawing is given, embracing plane projection drawing, isometric drawing, descriptive geometry, and the elementary principles of lettering, coloring, and shading, with original problems executed in the drawing-room. Examples from numerical data are always given when suited to the conditions of the problem in hand. Students in mechanical engineering are required to sketch pieces of machinery, and afterward to make working drawings suitable for use in the shop. The plans of surveys, plane-table work, maps, designs in engineering construction, and the thesis drawings naturally come under this head. Instruction is also given in free-hand drawing, topographical drawing, ornamentation and lettering, shades and shadows, linear perspective, and drawing for stone cutting. The work in drawing occupies the student a part of almost every day throughout the course.

There are five large and well-lighted drawing-rooms, three of which are in the engineering building and two in the engineering laboratory. There are also special rooms for blue-printing and a dark room for photography.

Mechanical Practice and Shop Work.—The aim of the instruction in this department is to make the student, as far as time will permit, acquainted with the best mechanical practice; the instructors in all practical work are men of wide experience, selected for their mechanical skill; and the department attempts to keep in touch with the most improved methods of mechanical construction. All courses are under the direction of the Superintendent of Shops, and instruction is given in the various branches by the special shop assistants.

The courses of instruction all begin with a systematic series of graded exercises, to give the student familiarity with the common tools used in the particular branch of work he is pursuing; and in connection with each course, the theory of the process is taught by lectures or by assigned reading. The student thus becomes fitted to execute an ordinary piece of mechanical work and at the same time acquires familiarity with sources of information bearing upon such work. At a later stage in the course the student is taught to apply the principles previously studied in the classroom, and to combine skill and knowledge in the transformation of crude materials into articles which have a market value.

class goes into camp in a favorable locality as a field party. A survey is made for some line of communication, usually a railroad, including exploration, preliminary and located lines, easements to curves, profile leveling, check levels, profile making, cross-section data, cross-sectioning, transfer of line to plugs near grade points, witnessing, and, in general, the preparation of the line for construction up to the point of beginning excavation. In this connection good field and office records are required; profiles and maps are made; and the necessary computations, including those for earthwork quantities, are worked out.

In addition to the railroad survey, some other piece of field work is undertaken, the selection being made according to the fitness of the locality, the number and the previous experience of the members of the class, the time, and the weather, the purpose being to fix, by practical application, the principles learned from text-book, lectures, or previous experience. Within the past few years, work of the character indicated below has all been done, though not all in any one year: small triangulation surveys, in which there is considerable reading of angles; compass surveys; shore-line surveys; surveys for special purposes, like town sites, bridge sites, cemeteries, or particular areas of unusual shape; resurveys of the United States Land Survey, including the finding and restoring of lost corners, and the subdivision of sections; contouring; hydrography; gauging of streams; leveling for special purposes, such as mill powers, lake levels, and the determination of the fall of streams; and, in general, any ordinary piece of field work, for which the locality chosen for the camp may afford favorable conditions.

The work in camp also includes office work along the various lines of field work, such as the computation of triangulations; reduction of careful measurements; calculation of earthwork, azimuth, areas, and elevations; mapping; platting; and profile-making.

(*b*) *For Students in Mechanical and Chemical Engineering.*—The student in mechanical engineering takes a short course in the use of instruments, which is nearly all practice. He is required to read angles with a transit; to make a traverse; to make steel-tape measurements; to do simple leveling; and to compute and plat an inclosure survey. The aim of the course is to cover the simple manipulations in the ordinary use of surveying instruments, and to qualify the student for such duties in this line as are apt to fall to the mechanical engineer, such as mapping an inclosure, staking out a building and fixing the levels for it, laying out foundations for machines or boilers and establishing the levels for them, lining up shafts, setting water power machinery, and preparing lines for transmission of power by wire-rope, compressed air, or water.

(*c*) *Other Courses.*— Courses in Land Surveying, the United States Land Survey, the Canadian Survey, and in other specialties are provided, if properly qualified persons present themselves in sufficient number to form classes.

Geodesy.— For students prepared to undertake the work a course is offered, comprising lectures, reference reading, and written class reports, on geodetic methods in the field with special reference to successful present-day practice. Some consideration is given to notable historical surveys, and constant use is made of reports and standard works of reference.

Highway Construction. — A course of lectures, and text-book work, is given to students of civil engineering, on the construction and maintenance or roads, streets, pavements, and walks. References are made to existing examples and present practice. Byrne's Highway Construction is used as a text-book.

Municipal Engineering.— A course of lectures, prescribed reading, and recitations covers the special field of city engineering, points out its connection with, and dependence upon, other branches of engineering work, and shows how to apply the principles of engineering to the modern problems arising in the building and improvement of cities. Among the topics treated are streets and their present uses, sewers, waterworks, public franchises, assessments, bridges, building inspection, fires, street lighting, street cleaning, and garbage disposal. The instruction is not intended to be of a technical character, but it aims to set forth the principles that should guide the city engineer in his relations to various matters of public concern, and to supplement and apply to this special field the instruction given in other courses. This course should not be taken by undergraduates before their last year of residence.

Strength and Resistance of Materials. — A course of recitations and lectures continuing through the first half-year is devoted to this subject, and is attended by all the engineering students except those pursuing the chemical engineering course. Simple and restrained beams and girders, shafts, pieces under tension, columns and struts are analyzed for different conditions of load; riveted work is computed; the action of the different materials under applied forces, the distribution of stress, and the proper proportions to be given to the different parts and details of structures in order that they may safely fulfil their several functions are carefully studied. Greene's Structural Mechanics is used as a text-book.

Tests of wood, iron, steel, cement, and other building materials are made in the Engineering Laboratory.

Theory of Structures. — Roof and bridge trusses, in wood and iron; arches, in wood, iron, and stone; trestles; brick and stone masonry; foundations; tunnels; and, in general, the whole theory of structures are discussed. In this course Rankine's Civil Engineering is used as a text-book, supplemented by full explanations, additional notes, lectures, examples, and problems, and illustrated by models, photographs, working drawings, and blue-prints.

Graphics. — A course of instruction extending through a year is given in the graphical analysis of roof and bridge trusses and arches under steady load, wind pressure, and moving loads. The student is made familiar with both the analytical and graphical methods of treatment, and thus possesses ready proof of the accuracy of his calculations. Greene's Roof Trusses, Bridge Trusses, and Arches are used as text-books.

Hydraulics. — The laws of the flow of water through orifices and pipes and over weirs; the gauging of streams and rivers; the designing of works for water supply, drainage, and sewerage; the laying out of canals; and the subject of river and harbor improvements are treated in this course. The text-book used is Merriman's Hydraulics.

Machinery, Prime Movers, and Power Transmission. — A course of instruction is given in mechanism, or the general principles of machinery, involving the study of gearing, screws, cranks, and levers, and the dynamics of machinery. In the study of prime movers, special attention is given to turbine and other water motors, and to steam engines. In the theory of machine construction, problems involving the strength and design of machines, and the materials used in their construction, and also involving the application of the principles of electricity, are studied at length in connection with such examples as illustrate the best practice. The instruction in power transmission covers the distribution of power by shafts, belts, rope, hydraulic and pneumatic transmission, and the arrangement of shafting and machinery in manufacturing establishments. Practical problems involving the strength of shafting, belting, and gearing are fully treated. Tests are made to determine the efficiency of machines and the value of lubricants.

Design of Shop Machinery. — The student is taught to design one or more of the standard machines used in shops. He is shown how to combine his theoretical and his practical knowledge so as to conform to the best mechanical practice. He designs one or more complete machines, and makes a detailed drawing of each part for shop use. The drawings that possess merit and are carefully worked out are subsequently used in the shops. Instruction is also given in blue-print work. The course is intended in every respect to represent, as far as possible, the operations of actual business.

Designs in Engineering and Machine Construction.— Contemporaneously with the study of theory, students are required to work out problems in design. They are furnished with the usual data for a design, and the kind or type of structure or machine is indicated. They are then expected to make the necessary calculations, paying particular attention to proportioning the different parts so as to secure strength, simplicity, and effect, and to present at a specified date complete working drawings, giving full details, accompanied by bills of materials, estimates, and specifications.

Metallurgy.— A course of instruction by lectures and recitations is given upon the subjects of fuel, refractory material, iron, and steel. The lectures are illustrated by charts and drawings of furnaces and appliances used, and by samples of furnace products.

Thermodynamics.— This course embraces the study of the principles governing the action of heat engines in general, hot-air and gas engines, air compressors, compressed-air engines, and refrigerating apparatus.

Steam Engineering.— The work in this branch covers the practical use of steam. Furnaces and boilers are studied with reference to proper combustion of fuel; to securing maximum evaporative efficiency; and to proportioning the parts for strength, durability, and accessibility for cleaning and repairs. The care and management of engines and boilers, both in use and out of use, are fully considered. A study is made of the principal steam pumps and pumping engines. Tests are made to determine the value of fuels, quality of steam, and the efficiency of furnaces, boilers, and engines.

Gas Engines, Compressed Air, and Refrigeration.— The theory is discussed under thermodynamics. Additional courses are given, covering the application of the theory, mechanical details of construction, and methods of operation.

Heating and Ventilation.— A course of lectures and recitations is given covering the theory of heat as applied in heating, the design and construction of hot air, direct and indirect steam, hot water, and fan systems of heating. Plans are made for different systems, and plants inspected.

Primary and Storage Batteries.— A brief course combines theory and experimental work in measuring electromotive forces, polarization, internal resistance, and efficiency. Several types of storage cells are in constant use,

Electrical Measurements. — This course extends through an entire year, and is devoted to practical work in the laboratory with the most modern apparatus. In addition to exact methods of measuring resistances, electromotive forces, and currents, it includes the calibration of the measuring instruments employed, the determination of capacity in absolute measure, the measurement of inductances, and the determination of the hysteresis curves of iron and steel.

Dynamo Electric Machinery. — The time given to this course is about equally divided between the study of the theory of generators and motors, and the determination in the electrical engineering laboratory of characteristic curves, of the series turns required to compound for constant potential, and of the efficiency of generators and motors.

The mechanical and chemical engineering students are expected to take this course in the summer school session between the third and fourth years.

Alternating Current Machinery. — To the theoretical study of this subject is added laboratory work with alternators, transformers, and two-phase or three-phase transmission.

Design of Electrical Machinery. — The course in electrical design gives the fundamental principles and illustrates them by numerical calculations of electromagnets, of direct current machines, motors, alternators, and transformers. The lecture course is supplemented by exercises in drawing in which each student makes working drawings to accompany his own designs. Highly satisfactory transformers, two-phase and three-phase generators, and induction motors have been built by electrical engineering students in the engineering shops.

Industrial Chemistry. — Under this head come those courses which treat of chemical processes on a manufacturing scale. The chief subjects are: Fuels; gas; iron and steel; water; the acid, alkali, cement, and glass industries; by-products from coal and wood; starch, glucose, and sugar; fermentation and distillation; fats, oils, and soaps; bleaching and dyeing; tanning; the paper manufacture, etc.

Chemical Engineering. — This course is designed to meet the demands of manufacturers for men capable of intelligently directing manufacturing processes and handling machinery. To this end sufficient chemistry is introduced into the course to enable the graduate to act as his own chemist on most occasions. The instruction includes thorough laboratory drill in qualitative and quantitative analysis, courses in organic chemistry, chemical technology, metallurgy, and a special laboratory course in connection with some chosen manufacturing industry.

The engineering studies are, in the main, those required for the course in mechanical engineering; the student gains a knowledge of the construction and use of machinery, and has practical drill in the drawing-rooms and shops; but the chemical studies indicated above take the place of the advanced mathematics and the higher work in engineering design.

By a proper selection of elective studies, and an additional year of college work, the graduate in chemical engineering can also secure the degree of Bachelor of Science in mechanical engineering.

Ship Calculations.— The subjects treated under this heading are connected with the displacement and buoyancy of ships, and include the investigation of rules for determining areas and volumes, calculation of center of buoyancy, metacenter, change of trim, capacity of hold, etc. The theory and use of the planimeter and integrator are also discussed.

Strength of Ships.— In this course are included the general consideration of structural details, types of ships, and the various classification societies' rules; method of obtaining curves of weight and buoyancy, shearing force and bending moment, under various conditions of wave support. The effect of pitching and heaving is also considered, and riveted joints are discussed.

Stability of Ships.— This course embraces the investigation of methods for obtaining curves of stability and cross curves, and of the effect of freeboard, etc., upon stability. The geometric properties of the surfaces of buoyancy, flotation, and metacentric evolute are examined. All problems relating to the resisted and unresisted rolling of ships, in still water and in waves, and methods of reducing rolling, are also included in this course.

Resistance and Propulsion of Ships. — Under this heading are treated all questions relating to the resistance of vessels, such as surface friction and wave-making and eddy-making resistance. The effect of form, Froude's law of comparison, progressive trial trips, and the use of the data obtained therefrom are discussed. Investigations of the action of different propellers, and the general trochoidal theory of waves fall under this head.

Practical Shipbuilding.— A course of lectures is given on arrangements of shipyards, methods and sequence of work, preparation of working plans, specifications, etc. Methods of estimating weights and cost, arrangements for pumping, heating, and ventilation are also discussed.

Marine Engineering.— Under this heading are treated the theoretical and practical considerations governing the design and construction of marine engines and boilers of various types. Details of construction, weight, and space occupied, vibrations, and methods of balancing engines, are also treated, together with the design and arrangement of auxiliary machinery.

Drawing and Design.— The above courses are accompanied by work in the drawing room, which will include: Laying off and fairing a set of lines from given offsets; calculations of displacement, center of buoyancy, etc., and plotting results; construction of capacity curves; calculation of change of trim and curves connected therewith; of launching; of strength and determination of curves of weight, buoyancy, shearing forces and bending moments; calculation of stresses; of curves of stability.

Later, the student will work out a design for a vessel to fulfil given conditions, as, for instance, a fast passenger or cargo steamer, cruiser, battleship, torpedo boat, or steam yacht, and will prepare the lines, general arrangement, midship section, and all calculations connected with the above, and if time permit, a complete set of working plans, together with an order form and specification.

In marine engine drawing the student will design a marine boiler with all details, and also a marine engine with as many of the detail plans as possible, and will make all necessary calculations.

Visits of Inspection.— As often as practicable, visits are paid to neighboring manufacturing establishments, to electric light and electric power stations, and to points of engineering interest, for the purpose of acquiring a knowledge of the methods employed in building, in the construction of bridges, machinery, and ships, and the best practice in electrical manufacturing and engineering on a large scale.

Examinations.

Examinations, usually in writing, are held at the end of each semester, but the classes are liable to be examined at any time, without notice, on any portion of their previous work.

FACILITIES FOR INSTRUCTION.

The collections for illustrating the instruction given comprise models, drawings, photographs, lithographs, and blue prints representing trusses, arches, and details of construction in iron, wood, and stone; sections of valves, pumps, and injectors; indicators and [illegible]ng models in various lines and full-sized machines;

working drawings of bridges, engines, dynamos, etc. These collections are receiving additions from year to year, by gift and purchase, and are invaluable to the student.

Tests of engines and boilers, and of machinery in general, will be made on request, and the profit of such work devoted to extending the facilities of the engineering laboratory. The data of all experiments and tests made are kept in the laboratory records. Tests of materials are also conducted for private parties, and reported upon when desired.

All the laboratory work is on a practical basis, and is done as nearly as possible as it would be done in any well-arranged manufacturing establishment. There is a metallurgical laboratory connected with the chemical laboratory, supplied with assay furnaces and other appliances. The latest and best books on professional subjects are added yearly to the library, where they are accessible to all; and frequent references are made to them in the class room as the various subjects are brought forward.

Physical Laboratory.

The basement of the physical laboratory is devoted entirely to experimental work in electricity and magnetism. All of this work is open to students in physics.

On the first floor are a commodious lecture room, an apparatus room, a general laboratory for elementary work, a balance room, a mercury room, and two rooms for a private laboratory.

The laboratory is supplied with the most modern apparatus from the best American and European makers. In sound, it includes tuning forks and resonators from Koenig, of Paris; in light, a spectrometer with 12-inch divided circle, an ophthalmo-spectroscope from the Geneva Society, an optical bench, with accessories, from Duboscq, a Zeiss focometer, spectrometer, and interferometer, and a polarimeter from Schmidt and Haensch.

The work in the laboratory is entirely quantitative in character, but provision has been made for illustrating the general principles and laws of physics in the lecture courses.

Chemical Laboratories.

The chemical laboratories provide for classes in general, analytical, organic, and physical chemistry, in pharmacy, in chemical technology, and in metallurgical assaying. They also provide for original research in the several branches of chemical science and for independent investigations in technology. In the course of the year, classes are formed in forty-six distinct courses of study. I the greater number of these courses the method of work combines training in laboratory operations with instruction by lectures and conference, these methods being united in one course.

The chemical building contains in all about 37,000 square feet of floor space. Besides the rooms for recitations, storage, administration, etc., the laboratories for students have an area of about 25,000 square feet.

The laboratory of general chemistry is separately organized. Courses in elementary inorganic chemistry, as well as in physical chemistry and the advanced branches of the science are offered; research work both in inorganic and in organic general chemistry is also arranged for a limited number of students. Modern apparatus is on hand for all the varieties of work that are liable to be undertaken, and a well-equipped balance room is provided.

The laboratories of analytical chemistry, organic chemistry, pharmacy, and chemical technology are carried on together. There are separate work rooms for qualitative analysis, quantitative analysis, iron and steel analysis, electrolytic work, pharmaceutical preparations, organic preparations, organic analysis, physiological chemistry, and assaying of ores,— as well as rooms for the weighing-balances and instruments of precision, for gas analysis, and for optical work. The rooms fitted up for chemical technology in various industrial branches have nearly 3,000 square feet of floor space. There are eleven separate rooms for original research, two lecture rooms, and two recitation rooms. In the ventilation of the work rooms the supply of fresh air is enforced by driving fans, and the removal of foul air is effected by draught flues and by electric-motor fans, with which, also, working hoods are connected.

The chemical laboratories are open throughout the college year to all students of the University, and are regularly used by the several departments. They are also open to any person who wishes to pursue special studies therein, provided he complies with the conditions for admission to that department of the University to which the desired special studies properly belong.

Over three hundred students are engaged in these laboratories at the same time, each at a table provided for one worker. During the year from 600 to 700 students complete from one to five courses of study each in the various branches of chemistry. The students engage in chemical work as it is needful for their different purposes, — the pursuit of science, or the preparation for teaching, for the several professions applying chemistry, and for the various chemical arts and industries.

Engineering Shops.

The engineering shops are in a group of connected buildings and now occupy about 17,000 square feet of floor space devoted to shop work. The shops will be very considerably enlarged in the near future.

The *Carpenter and Pattern Shop*, 40 by 80 feet, is equipped with the tools and machinery usually found in a first-class establishment. One end of the shop contains the work-benches and the tools needed for hand work; the other contains a good variety of wood-working machinery, much of which was built in the shops. Above the wood-room a pattern-loft, 40 by 80 feet, contains a large collection of patterns made by students during the past few years.

The *Foundry*, 30 by 80 feet, is equipped with two iron cupola furnaces, one capable of melting six hundred pounds, and the other two tons, of iron an hour; two brass furnaces of a capacity of 150 pounds each; a modern core-oven; elevator; crane; blowers; and a supply of flasks and small tools adapted to the work to be done. A large part of this equipment was made in the shops.

The *Blacksmith Shop*, 30 by 40 feet, contains twelve forges and anvils, a drill press, an emery wheel, a punching and shearing machine, pressure and exhaust blowers, and many small tools.

The *Machine Shop*, 40 by 80 feet, contains lathes, planing machines, drill presses, milling machines, a shaper, grinding machines, and other tools for working in iron. Much of the machinery was made in the shop. The tool room is well supplied with small tools.

The *Drawing Room*, 32 by 54 feet, is supplied with blue-print apparatus, drawing desks, and other furniture needed for the use to which the room is put.

The central portion of the building, 32 by 54 feet, contains in the basement a well-ventilated wash-room, and on the first floor an engine room with a 10 by 30 Reynolds-Corliss engine, a storeroom, and an office for the superintendent. Here is also a room in which instruction is given, in the construction and maintenance of scientific laboratory apparatus, to students preparing to teach science.

New machinery is added to each shop from time to time for the accommodation of engineering students and others desiring instruction and practice in the use of tools for working in wood and metal. Opportunity is afforded to become familiar with the more common materials and forms of construction used in engineering structures, buildings, and machinery. In all work an effort is made to follow *the practice of the* best shops.

Engineering Laboratory.

The *Engineering Laboratory* is devoted to experimental work in connection with the testing of engines, boilers, pumps, indicators, belting, gearing, lubricants, and strength of materials, and to such original work as can be undertaken with advantage. The work also extends to the testing of engines, boilers, and water-wheels of neighboring mills and electric plants. The Knowles and the Gordon pumping engines at the City Water Works have been fitted up by the company with special reference to the convenience of engineering students in making tests. The equipment contains, among other things, a 100,000-pound Olsen testing machine; a 2,000-pound cement testing machine; Thurston and Ashcroft oil testing machines; a Stirling boiler for high pressure; a high speed automatic engine; a Corliss engine; a Rider hot-air engine; Wheeler and Wainwright surface condensers; an Alden absorption dynamometer; a Giddings traction recording dynamometer; an Emerson power-scale; several other forms of dynamometers; a large, electrically driven chronograph, built in the laboratory; a 36-foot open mercury column; special apparatus for testing pressure and vacuum-guages and indicator springs; gauges; indicators; thermometers; pyrometers; tachometers; standard weights; steam pumps and injectors; rotary and centrifugal pumps; water meters; water motors, including a special universal water motor, built in the laboratory, together with pressure tanks and pumps for testing motors; hydraulic rams; water-wheels; air-pumps; blowers; apparatus for making tests on radiators and pipe coverings; apparatus for furnace gas analysis; a street railway motor; and other apparatus having special reference to work of investigation.

A considerable increase in the space devoted to experimental work and testing was made last year. Extensive additions of rooms and greatly improved facilities in these lines will be provided in the new building, made necessary by the increase in the number of students; its erection will be begun the coming season.

Electrical Laboratory.

The entire ground floor of the physical laboratory is devoted to experimental work in electricity. The rooms for electrical measurements contain solid stone-capped piers, and currents under a pressure ranging from 2 to 220 volts are available.

The laboratory is supplied with apparatus from the best American and European makers. It contains galvanometers and resistance [illegible],000 units from Edelmann, Hartmann & Braun, Elliott [illegible]others & Co., Queen & Co., Willyoung & Co., and

Otto Wolff; a series of ammeters and voltmeters from the Weston Co., for both direct and alternating currents; also wattmeters, condensers, electrodynamometers, electrostatic voltmeters, three Kelvin balances, standard cells, standard resistance coils with certificates from the Reichsanstalt, standard condensers, and an Ayrton & Perry standard of self-inductance.

In the dynamo room are two 10-light arc machines, two constant potential machines, and a 33 K. W. composite wound alternator made for the University by the Fort Wayne Electrical Corporation, and an 8 K. W. rotating converter. These are all run by electric motors varying from 2½ to 50 horse-power. In addition, two small alternators of 60 and 125 cycles respectively are used for two-phase and three-phase experimental work. Arc lamps, banks of incandescent lamps, resistances, rheostats, transformers, and storage batteries complete the equipment. The transformers include a set for conversion from two-phase to three-phase transmission and the reverse. A well equipped photometric room adjoins the dynamo room.

The new University lighting plant, consisting of two 75 K. W. Thompson-Ryan generators and one 25 K. W. Westinghouse generator, is available for instruction in the department. The two large machines are connected by the Arnold system to two 15 by 14 engines and run at a speed of 250 revolutions per minute. The Westinghouse machine is directly connected to a Russell 9 by 12 automatic engine running at 300 revolutions per minute. The latter is located at the hospitals. These may be lighted independently, or may be supplied with current from the central plant on the campus by means of heavy mains and a " booster." The system is a 220-volt one throughout, with both incandescent and arc lamps (two in series) on the same circuits. All the feeders and mains are underground, except those running from the central plant to the hospitals and to the observatory.

The Arnold system permits of connecting either dynamo to either engine, or of disconnecting either so that it may be tested for efficiency by purely electrical methods. A large number of motors, varying in capacity from 1 to 50 H. P., are in service and are available for testing purposes.

The new building for the Department of Engineering, work upon which is expected to begin in the spring of 1902, will afford largely increased facilities for experimental work in electrical lines.

Astronomical Observatory.

The observatory is known as the Detroit Observatory, having been founded through the liberality of citizens of Detroit. Valuabl additions and improvements have been made by contributions from several sources. The building consists of a main part, with a movable dome, and two wings. The meridian circle in the east wing was constructed by Pistor & Martins, of Berlin. In the main part are mounted clocks by Tiede & Howard. The west wing contains the observatory library, which connects with the residence of the Director. The refracting telescope, mounted in the dome, has an object glass thirteen inches in diameter. It was constructed by the late Henry Fitz, of New York.

A small observatory near the main building is used in the work of instruction. It contains an equatorial telescope of six inches aperture, and a transit instrument of three inches aperture, with zenith telescope attachment. A certain amount of practice in determination of time, latitude, and longitude is required of all civil engineering students.

Geological Laboratory.

Opportunity for practical work in geology is provided in rooms set apart for this use in the Museum building. The rooms are furnished with microscopes, photographic instruments, cutting and polishing lathes, and other apparatus for the preparation of specimens. Special encouragement and assistance are given to students wishing to carry on original investigations.

The Libraries.

The various libraries of the University contain about 145,000 volumes, and include a number of important special collections. The portion devoted to engineering contains the standard works in this department of science, and the files of important society proceedings and professional periodicals. Seven hundred and seventy-five periodicals are received.

The catalogue of the library is the usual card catalogue of authors and subjects.

Members of the Faculties and other officers of the University may draw books from the library, subject to certain restrictions. To all other persons it is a reference library. The reading room for general use will seat 210 readers. Separate rooms are provided for advanced students where work is pursued with the necessary books at hand.

The library is open for consultation fourteen hours daily during the academic year, nine hours daily during the six weeks of the Summer School, and six hours daily from the close of the Summer School until the end of the summer vacation. The only exceptions [illegible] above are Sundays and legal holidays.

The Engineering Society.

Several organizations of students are maintained, aside from the usual literary societies, for the reading of papers and holding discussions in various scientific lines. The Engineering Society, composed of and officered by students of this department, holds meetings, at which papers of technical interest are read, and reports made upon observation and experiments. A reading room is maintained by the society, accessible to all students of the department. Several engineers of prominence have spoken before the Society in past years. An annual, called the Technic, containing papers read before the Society, abstracts of theses, contributed articles from alumni, and other matters of professional interest, is published by the students.

The Summer School.

The Summer School, in session from June 25 to August 8, 1902, affords opportunity for study in languages, history, mathematics, natural, physical, and applied science, and for work in the drawing rooms, shops, and laboratories. Students who wish to review studies preparatory to presenting themselves for examination for admission to the Department of Engineering will find courses directly adapted to meet their wants. A special Announcement can be had by addressing Mr. James H. Wade, Secretary of the University, in April or May.

The Laboratories. — For a full account of all the laboratories and their various resources, as also of the University collections for the study of art, archeology, ethnology, mineralogy, paleontology, systematic zoology, etc., consult the annual Calendar, which may be had gratis on application to Mr. James H. Wade, Secretary of the University. Those laboratories closely connected with the Department of Engineering are described in the preceding pages.

University Organizations.— An attractive series of lectures and musical entertainments is provided each year at a low price by the Students' Lecture Association. The Choral Union is an organization of students and others for the study and practice of choral music. A course of concerts and a festival of three days in May are announced under its auspices each year.

The Oratorical Association fosters an interest in oratory, and its members have been remarkably successful in recent contests.

FACILITIES FOR PHYSICAL CULTURE.

Waterman Gymnasium.— The University is provided with an excellent Gymnasium which has cost about $65,000. The main flo which is a rectangle with truncated corners and dimensions of 150 by 90 feet, is well equipped with the various kinds of apparatus usually found in the best modern gymnasiums. A number of smaller rooms are devoted to administration, fencing, boxing, and other special purposes, while the basement is given up to baths and lockers. The main hall is lighted in the daytime by means of a large skylight 60 feet above the floor, and in the evening by electricity. A gallery makes room for an elliptical running-track 375 feet in length.

In the conduct of the gymnasium the aim is not so much the development of a few gymnastic experts as the provision of wholesome physical exercise for the many. *Attendance twice a week is required of all first year students of this department.* The facilities of the building, including physical examinations and instruction, are free to all students, the only charge being a rental of $2 a year for a locker.

An athletic field of ten acres has been set apart and equipped for open-air sports. Room is also provided for tennis courts. Foot-ball and base-ball are practiced by class and University teams.

COURSES OF INSTRUCTION.

The Courses of Instruction are subject to change from time to time; those proposed for the year 1902–3 and required for graduation, as stated on pages 54 to 56, are described below, together with some advanced elective and technical courses, which are designated accordingly. The amount of credit towards graduation assigned to each course is indicated by the expressions *one hour, two hours,* etc., an *hour of credit* being given for the satisfactory completion of work equivalent to one exercise a week during one semester. Lectures and recitations are usually one hour in length, but in laboratory work, drawing, and other practical exercises, a longer attendance is required in order to secure an hour of credit.

Courses given in the Department of Literature, Science, and the Arts, are (with the exception of the courses in French and in German, for which special permission is required) all open as electives to engineering students who can spare the time and are qualified to pursue them with advantage.

A student enrolled in the Department of Literature, Science, and the Arts, and desiring to elect any work in this Department, must obtain written permission from the Dean of the former Department, have it approved by the Dean of the Department of Engineering, and attach the paper to the election slip.

Students will be classified and assigned to sections by a Committee of the Faculty.

RULES AND REGULATIONS.

The work of students must be arranged in conformity with the following regulations: —

a. Before entering on any study the student must give the instructor satisfactory evidence that he is prepared to pursue it with advantage.

b. No student will be allowed to elect merely a part of a course, without special permission of the Faculty.

c. No credit will be allowed to a student for work in any course, unless the election of the work is formally entered on his classification blank before the work is begun.

d. After the first Saturday of each semester no study can be taken up or dropped without special permission of the Faculty. All requests for permission to take up or drop studies must state clearly in writing the circumstances of the case and the subjects and number of hours to be carried in case permission is granted.

e. The Faculty requires a student to drop a part of his work at any time, if in its opinion he is undertaking too much; or to take additional work, if it thinks he is not sufficiently employed.

f. The Faculty reserves the right to withdraw the offer of any elective study not chosen by at least six persons.

g. In cases of exceptional proficiency, permission to take hours in addition to those named in the published schedule is granted by the Faculty on special request; but in all cases requests for permission to take an additional number of hours must be made in writing on a blank form provided by the Dean, and must be deposited in the Dean's box on or before the *first Saturday* of the semester during which the additional work is desired. No permission to take extra hours will be granted to students in their first semester of residence.

h. After matriculation, a student cannot, without special permission of the Faculty, be admitted to examination in any one of the courses given, until he has received in the University the regular instruction in such course.

REMOVAL OF CONDITIONS.

Examinations for the removal of conditions incurred in regular work will be held at three times during the year, viz., on the first Friday and Saturday after the close of the Summer Vacation, the Christmas Vacation, and the Spring Recess.

Students who wish to present themselves for examination in any subject as above must notify the ***instructor in charge*** as early as Wednesday before the examination.

Any student reported as ***passed conditionally*** in any course must remove such condition at one of the first two regular examinations for the removal of conditions immediately following the semester in which such condition was incurred; otherwise the course passed conditionally will be regarded as ***not passed.***

French.*

Mr. Frank.

FIRST SEMESTER.

A. Beginners' Course. *Three hours.*

C. or D. Scientific Reading. *Three hours.*

SECOND SEMESTER.

B. Narrative Prose. *Three hours.*

E. Current Scientific Literature. *Three hours.*

German.*

Dr. Wait and Mr. Lange.

FIRST SEMESTER.

A. Elementary Course. Thomas's German Grammar, and a German Reader. *Three hours.*

C. or D. Scientific Reading. *Three hours.*

SECOND SEMESTER.

B. Elementary Course, continued. *Three hours.*

E. Scientific Reading, continued. *Three hours.*

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*A Student admitted on French will take French D. and E., German A., B. and C.
" " German will take German D. and E., French A., B. and C.
" " Latin will take French A. and B., German A., B. and C.
" " Latin and French will take French D., German A. and B.
" " Latin and German will take French A. and B., German D.

[illegible] who has obtained credit for six hours, (Courses A. and B.) in French, [illegible] on Latin, may substitute the two courses in Spanish for an equal [illegible] erman.

Spanish.

Mr. Frank.

FIRST SEMESTER.

A. Grammar and Conversation. *Three hours.*

SECOND SEMESTER.

B. Reading and Conversation. *Three hours.*

English.

Mr. Abbott.

FIRST SEMESTER.

1. Paragraph Writing. *Two hours.*

SECOND SEMESTER.

1*a*. Theme Writing. *Two hours.*

Higher language study is pursued in the Department of Literature, Science, and the Arts.

Mathematics.

Professor Ziwet, Assistant Professor Markley, Mr. Hall, Dr. Glover, Mr. Butts, Mr. Escott, Mr. Marshall, Mr. Ford.

Students of engineering are required to take in order Courses 1, 2, 3, 4, and 6. Those admitted with a deficiency in plane trigonometry may remove it by completing Course 1*b*, but the credit thus obtained is entered on the admission, not the graduation requirements. Other and advanced courses are given in the Department of Literature, Science, and the Arts.

FIRST SEMESTER.

1. Algebra and Analytic Geometry (I). *Four hours.*
1*b*. Plane Trigonometry. *Two hours.*
3. Calculus. *Five hours.*
6. Calculus and Mechanics (II). *Five hours.*

SECOND SEMESTER.

2. Analytic Geometry (II). *Four hours.*
4. Calculus and Mechanics (I). *Five hours.*

Physics.

Professor Carhart, Professor Patterson, Professor Reed, Assistant Professor Guthe, Mr. Randall, Mr. Pyle.

EITHER FIRST OR SECOND SEMESTER.

3. Physical Laboratory Work for Beginners. This course may be *elected as 3a, three hours;* or 3b, two hours. Fee: for *Course 3a, $3, for 3b, $2,*

Course 3 must be preceded or accompanied by Course 1. Students presenting notebooks from High School physical laboratories approved by this department, by electing Course 3*a*. may be allowed *three hours* of credit for *two hours* of work.

3*c*. Laboratory Work in Mechanical and Electrical Measurements. *Three hours*. Fee, $3.

Course 3*c* must be preceded by Course 2. It is designed for students who wish to prepare for the study of dynamo-electric machinery.

FIRST SEMESTER.

2. Heat, Electricity, and Magnetism. Lectures and recitations. *Five hours*.

Course 2 must be preceded by Course 1 and Chemistry A.

7. Mathematical Electricity and Magnetism. *Three hours*. (Elective.)

Course 7 must be preceded by Course 2. A knowledge of calculus is required.

8. Heat. Laboratory work. *Two hours*. (Elective.)

Course 8 must be preceded by Course 2. Fee, $2.

9. Theory of Heat. *Two hours*. (Elective.)

SECOND SEMESTER.

1. Mechanics, Sound, and Light. Lectures and recitations. *Five hours*.

For Course 1 a knowledge of plane trigonometry is indispensable.

10. Mathematical Electricity and Magnetism. *Two hours*. (Elective.)

Course 10 must be preceded by Course 7.

16. Theories of Solutions, Electrolytes, and the Voltaic Cell. Lectures and laboratory work. *Three hours*. (Elective.)

Course 16 must be preceded by Course 2 in electrical engineering and by Course 1 or A in chemistry. It is also desirable for the student to have had laboratory work in chemistry. Fee, $1.

Chemistry.

Professor PRESCOTT, Professor JOHNSON, Professor CAMPBELL, Assistant Professor GOMBERG, Mr. WHITE, Dr. SULLIVAN.

Other courses in Chemistry are given in the Department of Literature, Science, and the Arts.

EITHER FIRST OR SECOND SEMESTER.

A. **Principles** of inorganic chemistry. Lectures and recitations. *Three hours*.

Open to those who have passed the entrance requirements in Chemistry.

B. Qualitative Analysis. Recitations and laboratory work. *Seven hours.*

Open to those who have completed Course A or an equivalent.

C. Quantitative Analysis. Beginning course. Recitations and laboratory work. *Five hours.*

Open to those who have completed Course B.

D. Advanced Quantitative Analysis. Laboratory work. *Five hours.*

Open to those who have completed Course C.

F. Organic Synthesis. Laboratory work. *Three, four, or five hours.*

Course F must be preceded by Course C and preceded or accompanied by Course E.

G. Iron and Steel Analysis. *Five hours.* Laboratory work, *daily.*

Open to those who have taken Course C and who receive special permission.

H. Independent Work in Mineral Analysis. Laboratory work. *Five hours.*

Open to those who have completed Course D.

I. Technical Gas Analysis, including Calorimetry and Photometry. Laboratory work. *Two hours.*

Open to those who have completed Course C and who receive special permission.

N. Technological Chemistry. Courses are regularly offered in: 1. The manufacture of hydraulic cement, with special reference to relation of composition and temperature of burning to physical properties. 2. Coal, gas, and its by-products. 3. Influence of heat and mechanical treatment on constitution of iron and steel. Other subjects may be chosen on consultation. *Hours and credit to be arranged with instructor.*

Course N must be preceded by Courses D and L, with Courses E and M in addition, if the subject chosen is in organic technology.

FIRST SEMESTER.

E. Organic Chemistry. Lectures and library studies. *Five hours.*

Open to those who have completed Course B.

K. Technical Examination of Gold and Silver Ores, including the Fire Assay. Laboratory work with lectures and reading. *Two hours.*

Open to those who have completed Course C. Course 2 in Mineralogy is recommended.

L. Chemical Technology. A study of chemical manipulations and reactions on a manufacturing scale. Fuels, water, the acid and alkali industries, clay products, cements and glass. Lectures, recitations, and assigned reading. *Five hours.*

Open to those who have completed Course B.

SECOND SEMESTER.

M. Organic Technology. The industrial chemistry of organic compounds. Destructive distillation of coal and wood with recovery of by-products; illuminating gas; starch, glucose and sugar; fermentation and distillation; fats, oils and soaps; bleaching and dyeing; tanning; paper manufacture. Lectures, recitations, and assigned reading. *Five hours.*

Open to those who have completed Courses E and L.

Metallurgy.

Professor CAMPBELL.

FIRST SEMESTER.

1. Fuel and Refractory Material, Iron and Steel. *Three hours.*

Course 1 must be preceded by Chemistry A.

2. Micro-Metallography. The study of the microscopic structure of metals as related to their physical and chemical properties. Laboratory work with reading. *One hour.* (Elective.)

Open only to those who have taken Course 1, and who receive special permission.

Astronomy

Professor HALL and Mr. SPROAT.

EITHER FIRST OR SECOND SEMESTER.

4. Practical Astronomy. Use of sextant and transit. *Three hours.*

Course 4 requires a knowledge of spherical trigonometry and of differential and integral calculus.

FIRST SEMESTER.

5. Spherical Astronomy. *Three hours.*

In Course 5 some standard work on spherical astronomy is rapidly read, and special subjects are given out for discussion. Courses 5 and 9 follow Course 4 and are intended for students interested in geodetic work.

13. Theory of Least Squares. *Two hours.*

SECOND SEMESTER.

9. Practical Astronomy: extended course. Hours of credit to *be arranged.*

Mineralogy.

Professor PETTEE.

EITHER FIRST OR SECOND SEMESTER.

1. Lectures and practice. *Two hours.*
   For Course 1 an elementary knowledge of chemistry is desirable.

Geology

Professor RUSSELL.

SECOND SEMESTER.

12. Elements of Geology. Text-book and lectures. *Three hours.*

Drawing.

Professor DENISON, Mr. WRENTMORE, Mr. GOULDING, Miss HUNT.

EITHER FIRST OR SECOND SEMESTER.

4. Free-Hand Drawing; Pencil; Pen and Ink; Sketching. *Three hours.*

FIRST SEMESTER.

1. Geometrical Drawing. *Two hours.*
10. Continuation of Course 8. *Two hours.* (Elective.)
    Course 10 must be preceded by Courses 4, 7, and 8.
13. Water-Color Drawing. *Three hours.* (Elective.)
    Course 13 must be preceded by Course 8. It can be taken only by special permission.

SECOND SEMESTER.

5. Descriptive Geometry. Recitations and drawing. *Four hours.*
   Course 5 must be preceded by Course 1.
6. Shades, Shadows, and Perspective. *Three hours.* (Elective.)
   Course 6 must be preceded by Course 5.
7. Free-Hand Drawing (advanced). *Three hours.* (Elective.)
8. Architectural and Water-Color Drawing. *Two hours.* (Elective.)
   Course 8 must be preceded by Course 1 or 4.
14. Stereotomy. *Two hours.*
    Course 14 must be preceded by Course 5.
16. Free-Hand Lettering. *Two hours.* (Elective.)
    Course 16 must be preceded by Course 1.
17. Spherical Projections. *One hour.* (Elective.)
    Course 17 must be preceded by Course 5.

Shop Practice.

Superintendent MIGGETT; Shop-Assistants PURFIELD, WINSLOW, COBB, MCDONALD, MILLER.

Lectures are given by the Superintendent upon general workshop construction, equipment, and management. Courses 1*a* to 5*a* may be continued by advanced students as Courses 1*b* to 5*b*.

Special arrangements are made for students who desire to take more advanced work in the shop courses with a view to preparing themselves for teaching these subjects.

EITHER FIRST OR SECOND SEMESTER AND SUMMER SCHOOL.

1*a*. Carpentry. *Two hours.* Fee, $5.
1*b*. Pattern Making. *Two hours.* Fee, $5.
2*a*. Blacksmithing. *Two hours.* Fee, $5.
3*a*. Foundry work. *Two hours.* Fee, $5.
4*a*. Machine Shop. *Three hours.* Fee, $5
4*b*. Machine Shop, advanced. *Two hours.* Fee, $5.
5*a*. Instrument Work. *Two hours.* Fee, $5.

Course 5*a* will be given only in the second semester, and must be preceded by shop practice Course 1*a*, and physics Course 3*a*, 3*b*, or 3*c*.

Surveying.

Professor J. B. DAVIS, Mr. WRENTMORE.

FIRST SEMESTER.

1. Surveying. Lectures, Text-book, and Field Practice. *Five hours.*

The field practice in Course 1 continues during favorable weather until Christmas.

4. Use of instruments. *One hour.*

SECOND SEMESTER.

2. Continuation of Course 1. Lectures and text-book. *Five hours.*

Course 2 must be preceded by Course 1.

5. Topography. Transit and Stadia. Plane Table. Camera. Field Work and Drawing. *Four hours.*
7. Geodesy. Geodetic Methods. Lectures and text-book. *Three hours.* (Elective.)

Course 7 must be preceded by Courses 1 and 2.

SUMMER SCHOOL.

3. Field Work in Camp. *Six weeks.*

Course 3 must be preceded by Courses 1 and 2. Except by special permission it is open only to students who are working for a degree in civil engineering.

Civil Engineering.

Professor GREENE, Professor J. B. DAVIS, Mr. GREEN.

FIRST SEMESTER.

1. Municipal Engineering. Lectures and text-book. *Five hours.* (Elective.)
4. Graphical Analysis of Structures. *Two hours.*
   Course 4 must be preceded by Course 3.
6. Engineering. Theory of Construction. *Two hours.*
   Course 6 must be preceded by Course 4 in mathematics.
7. Engineering Design. *Five hours.*
   Course 7 accompanies Course 6.
9. Hydraulics. *One hour.*
   Course 9 must be preceded by Course 6 in mathematics.
15. Highway Construction. *Two hours.*

PRIMARILY FOR GRADUATES.

11. Engineering Design (advanced). *Five hours.*
12. Water Supply and Sewerage. *Two hours.*

SECOND SEMESTER.

2. Tests of Materials. *One hour.* (Elective.)
3. Graphical Analysis of Structures. *Two hours.*
   Course 3 must be preceded by Course 4 in mathematics.
5. Strength and Resistance of Materials. *Three hours.*
   Course 5 must be preceded by Course 4 in mathematics.
8. Engineering. Theory of Construction. *Three hours.*
   Course 8 must be preceded by Courses 3 and 6.
10. Water Supply and Sewerage. *One hour.* (Elective.)
    Course 10 follows Course 9.

PRIMARILY FOR GRADUATES.

13. Economics of Railway Location. *One hour.*
14. Contracts and Specifications. *One hour.*

Mechanical Engineering.

Professor COOLEY, Professor DENISON, Assistant Professor ALLEN, Superintendent MIGGETT, Mr. ANDERSON, Mr. THORPE.

EITHER FIRST OR SECOND SEMESTER.

6. Machine Design. Machine Tools. *Two hours.*
   Course 6 must be preceded or accompanied by Course 2, and be preceded by Courses 1, 4, 5, in drawing.
10. Machine Design. Hoisting Machinery. *Three hours.*
    Course 10 must be preceded or accompanied by Course 8, and preceded by Course 6.

11. Laboratory Work. Steam Engineering. *Three hours.* Fee, $5.
Course 11 must be preceded or accompanied by Courses 4 and 7, or 15.

FIRST SEMESTER.

2. Elements of Mechanism. *Three hours.*
Course 2, for civil engineering students, is *two hours.*
Course 2 must be preceded by Course 1 in mathematics, and by Courses 1 and 5 in drawing.
4. Boilers. Steam Engines. *Two hours.*
7. Hydraulic Machinery. *Two hours.*
Courses 4 and 7 must be preceded by Course 4 in mathematics, and by Course 1 in physics.
8. Theory of Machine Design. *Three hours.*
Course 8 must be preceded by Course 5 in civil engineering.
15. Prime Movers. Water-wheels and Steam Engines. *One hour.*
19. Gas Engines. *Two hours.*
Course 19 must be preceded by Course 13.

PRIMARILY FOR GRADUATES.

16. Heating and Ventilation. *Two hours.*
Course 16 must be preceded by Course 4.
18. Hydraulic Machinery (advanced). *Two hours.*
Course 18 must be preceded by Course 7 or 15.
20. Laboratory Work. Advanced Course. *Two hours.*
Course 20 must be preceded by Courses 9 and 11.

SECOND SEMESTER.

1. Elements of Machines. Nomenclature. *Two hours.*
5. Mechanism: Valve Gears. *Two hours.*
Course 5 must be preceded by Course 2.
9. Laboratory Work. Power Measurements. Machine Testing. *Two hours.* Fee, $5.
Course 9 must be preceded by Course 4.
13. Thermodynamics; Steam and other Heat Engines. *Three hours.*
Course 13 must be preceded by Course 4.
14. Power Plants. Power Transmission. *Two hours.*
Course 14 must be preceded by Courses 4 and 7.
17. Compressed Air. Mechanical Refrigeration. *Two hours.*
Course 17 must be preceded by Course 13.

PRIMARILY FOR GRADUATES.

[illegible] Specifications and Contracts. *One hour.*
Course 21 must be preceded or accompanied by Course 14.
[illegible] Thermodynamics (advanced). *Three hours.*

Course 22 must be preceded by Course 13.

23. Machine Design (advanced). *Three hours.*

Course 23 must be preceded by Courses 10 and 12.

SUMMER SCHOOL.

12. Machine Design. Boilers and Engines. *Three hours.*

Course 12 must be preceded by Mech. Engineering 4, 5, 6 and Civil Engineering 5.

Electrical Engineering.

Professor Carhart, Professor Patterson.

FIRST SEMESTER.

2. Electrical Measurements: Recitations and laboratory work. *Four hours.* Fee, $3.

Course 2 must be preceded by Courses 1, 2, 3, in physics; a knowledge of calculus is required.

5. Alternate Current Apparatus. Recitations and laboratory work. *Three hours.* Fee, $1.

Course 5 must be preceded by Course 4.

6. Photometry of Electric Lamps. Recitations and laboratory work. *One hour.* Fee, $1.

7 Design of Electrical Machinery and Appliances. *Four hours.*

Course 7 must be preceded by Course 4.

SECOND SEMESTER.

1. Primary and Secondary Batteries. Recitations and laboratory work. *Two hours.* Fee, $1.

Course 1 must be preceded by Courses 1, 2, 3, in physics, and Course A in chemistry.

3. Electrical Measurements. Continuation of Course 2. Lectures and laboratory work. *Three hours.* Fee, $2.

4*a*. Dynamo-electric Machinery. Lectures, recitations, and laboratory work. *Four hours.* Fee, $2.

Course 4*a* must be preceded by Course 2.

4*b*. Dynamo-electric Machinery, as in Course 4*a*. *Three hours.* Fee, $1.

Course 4*b* must be preceded by Course 3*c* in physics.

8. Distribution of Electricity. Lectures and recitations. *Two hours.*

Course 8 must be preceded by Course 4.

10. Advanced Course in Design of Electrical Apparatus. Drawing. *Two hours.*

11. Telephone and Telegraph. *Two hours.*

Course 11 must be preceded by Course 4.

PRIMARILY FOR GRADUATES.

9. Alternating Current Phenomena. *Two hours.*
Course 9 must be preceded by Course 5.

SUMMER SCHOOL.

4*b*. Dynamo-electric Machinery, as in second semester. *Three hours.* For mechanical and chemical engineering students.

Mining Engineering.

Professor Pettee.

SECOND SEMESTER.

1. Exploitation of Mines. Methods of opening, laying out, and working mines. *Five hours.* (Elective.)
Course 1 requires a knowledge of mineralogy and general geology.

Chemical Engineering. (See *Chemistry.*)

Naval Architecture and Marine Engineering.

Professor Cooley, Professor Sadler.

FIRST SEMESTER.

1. Naval Architecture. Practical Shipbuilding. Calculations, and strength of ships. *Four hours.*
2. Marine Engines. *Two hours.*
3. Ship Drawing and Designs. *Three hours.*
4. Marine Engine and Boiler Designs. *One hour.*

SECOND SEMESTER.

5. Naval Architecture. Stability, resistance, and propulsion of ships. *Four hours.*
6. Marine Engines. *Three hours.*
7. Ship Drawing and Designs. *Three hours.*
8. Marine Engine Drawing and Designs. *One hour.*

PRIMARILY FOR GRADUATES.

9. Ship and Engine Specifications. *Two hours.*
10. Pumping and Ventilation. *One hour.*
11. Advanced Reading. *Three hours.*
12. Advanced Drawing. *Five hours.*

Courses 1 to 8 should be taken in the fourth year by students who expect to graduate in Marine Engineering.

[illegible]nts wishing to specialize in Marine Engineering will take [illegible] and 8 in Marine Engine and Boiler Design and Courses [illegible] Ship Drawing and Design.

SEQUENCE OF STUDIES.

The work of the first year is the same for all regular students. At the end of the first year, the student makes his choice to continue in the civil engineering, the mechanical engineering, the electrical engineering, or the chemical engineering course. The student, in any course but chemical engineering, who desires to graduate in marine engineering, will elect the work in naval architecture and marine engineering in his *fourth* year, as specified on page 53.

There is a limited opportunity for electives in some semesters, and credits obtained in advance at entrance may leave a place for substitutions. After the first semester of the first year the student may take work to the amount of ***eighteen hours*** (page 36), per week, as arranged by the classification committee; but he may wisely, in some cases, take a smaller number of hours, if he can in that way do more thorough work. See "Rules and Regulations," page 37.

ORDER OF STUDIES.

First Year.

FIRST SEMESTER.

	EXERCISES PER WEEK.
French or German C or D (See note, page 38).	3
English 1, Paragraph Writing.	2
Mathematics 1, Algebra and Analytic Geometry, I.	4
Drawing 1, Elementary Drawing.	2
Chemistry A.	3
Shop Practice 2*a*, Forging (one half of class); or 1*a*, Woodwork (one half of class).	2
	16

SECOND SEMESTER.

French or German E.	3
Physics 1, Mechanics, Sound and Light.	5
Mathematics 2, Analytic Geometry, II.	4
Drawing 5, Descriptive Geometry.	4
Shop Practice 1*a*, Woodwork, or 2*a*, Forging.	2
	18

Second Year.

FIRST SEMESTER.

CIVIL.	hours.	MECHANICAL.		ELECTRICAL.		CHEMICAL.	
French or Ger. A.	3	French or Ger. A.	3	French or Ger. A.	3	French or Ger. A.	3
Physics 2.	5	Physics 2.	5	Physics 2.	5	Physics 2.	5
Mathematics 3.	5	Mathematics 3.	5	Mathematics 3.	5	Chemistry B.	7
Drawing 4.	3	Drawing 4.	3	Physics, 3*b*.	2		
		Shop Work 1*b*.	2	Shop Work 4*a*.	3		
	16		18		18		15

Second Year.

SECOND SEMESTER.

CIVIL.		MECHANICAL.		ELECTRICAL.		CHEMICAL.	
French or Ger. B.	3	French or Ger. B.	3	French or Ger B.	3	French or Ger B.	3
English 1*a*.	2	English 1*a*.	2	English 1*a*.	2	English 1*a*.	2
Mathematics 4.	5	Mathematics 4.	5	Mathematics 4.	5	Physics 3*c*	3
Physics 3*c*.	3	Mech. Eng'g 1.	2	Drawing 4.	3	Drawing 4.	3
Drawing 14.	2	Shop Work 4*a*.	3	Elect. Eng'g 1.	2	Chemistry C.	5
Geology 12.	3			Shop Work 1*b*.	2		
	18		15		17		16

Third Year.

FIRST SEMESTER.

CIVIL.		MECHANICAL.		ELECTRICAL.		CHEMICAL.	
French or Ger. C.	3	French or Ger. C.	3	French or Ger. C.	3	French or Ger. C.	3
Mathematics 6.	5	Mathematics 6.	5	Mathematics 6.	5	Mathematics 3.	5
Surveying 1.	5	Physics 3*c*.	3	Mech. Eng'g 2.	3	Chem. E.	5
Mech. Eng'g 2.	2	Surveying 4.	1	Mech. Eng'g 4.	2	Chem. L.	5
Mech. Eng'g 4.	2	Mech. Eng'g 2.	3	Mech. Eng'g 6.	2		18
Mineralogy 1.	2	Mech. Eng'g 4.	2	Elect. Eng'g 2.	4		
	19	Shop Work 4*b*.	2		19		
			19				

Third Year.

SECOND SEMESTER.

CIVIL.		MECHANICAL.		ELECTRICAL.		CHEMICAL.	
Surveying 2.	5	Shop Work 3*a*.	2	Shop Work 4*b*.	2	Mathematics 4.	5
Surveying 5.	4	Civil Eng'g 3.	2	Civil Eng'g 3.	2	Chem. D.	5
Civil Eng'g 3.	2	Civil Eng'g 5.	3	Civil Eng'g 5.	3	Chem. M.	5
Civil Eng'g 5.	3	Mech. Eng'g 5.	2	Mech. Eng'g 5.	2		15
Elect. Eng'g. 4*b*.	3	Mech. Eng'g 6.	2	Elect. Eng'g 3.	3		
	17	Mech. Eng'g 13.	3	Elect. Eng'g 4*a*.	4		
		Mech. Eng'g 9.	2		16		
			16				

Summer School.

CIVIL.		MECHANICAL.		ELECTRICAL.		CHEMICAL.	
Surveying 3.	6	Elect. Eng'g 4*b*.	3	Shop Work 3*a*.	2	Elect. Eng'g 4*b*	3
		Mech. Eng'g 12.	3	Mech. Eng'g 12.	3		
			6		5		

Fourth Year.

FIRST SEMESTER.

CIVIL.		MECHANICAL.		ELECTRICAL.		CHEMICAL.	
Astronomy 4*.	3	Metallurgy 1.	3	Mech. Eng'g 15.	1	Metallurgy 1.	3
Civil Eng'g 4.	2	Civil Eng'g 9.	1	Elect. Eng'g 5.	3	Surveying 4.	1
Civil Eng'g 6.	2	Mech. Eng'g 7.	2	Elect. Eng'g 6.	1	Chem. I.	2
Civil Eng'g 7.	5	Mech. Eng'g 8.	3	Elect. Eng'g 7.	4	Mech. Eng'g 2.	2
Civil Eng'g 9.	1	Mech. Eng. 10 or 11*.	3		9	Mech. Eng'g 4.	2
Civil Eng'g 15.	2		12			Mech. Eng'g 7.	2
Mech. Eng'g 15.	1						12
	13 or 16						

Fourth Year.

SECOND SEMESTER.

CIVIL.		MECHANICAL.		ELECTRICAL.		CHEMICAL.	
Astronomy 4*.	3	Mech. Eng. 10 or 11*.	3	Elect. Eng'g 8.	2	Chem. N.	5
Civil Eng'g 8.	3	Mech. Eng'g 14.	2		2	Mech. Eng'g 6.	2
Mech. Eng'g 15.	1		5				7
	4 or 7						
Thesis.		Thesis.		Thesis.		Thesis.	

* One half the class each semester.

The order of studies here given is not absolutely rigid, but is strongly advised, as the days and hours laid down in the annual Program of Hours and Work are arranged to correspond with such order and avoid conflicts.

Total hours prescribed: civil engineering course, 129 hours; mechanical, 124 hours; electrical, 118 hours; chemical, 120 hours. Required for graduation, 130 hours.

A student who desires to take the degree of Bachelor of Science in *marine engineering,* after completing the above Order of Studies for *three years,* in any course except that for chemical engineering, will take the following work for the

Fourth Year.

FIRST SEMESTER.		SECOND SEMESTER.	
Civil Engineering 9.	1	Mechanical Engineering 9.	2
Mechanical Engineering 11.	3	Naval Architecture 5.	4
Naval Architecture 1.	4	Marine Engines 6.	3
Marine Engines 2.	2	Naval Architecture 7.	3
Naval Architecture 3.	3	Marine Engines 8.	1
Marine Engines 4.	1		
	14		13

Thesis.

To which the electrical engineering student will add Mechanical Engineering 4; or the civil engineering student will add Mechanical Engineering 15.

REQUIREMENTS FOR GRADUATION.

The Degree of Bachelor of Science.

To earn the degree of Bachelor of Science in civil, mechanical, electrical, chemical, or marine engineering, the student must secure *one hundred and thirty Hours of Credit* * in a prescribed course of study, as given below, and must present a satisfactory *thesis.* The diploma given indicates the line of study pursued. A time limit is not fixed; but four years is usually needed for the completion of the 130 hours of work.

Bachelors of Arts, of this University, and graduates of any other reputable college, are excused from some portions of the general requirements, and are recommended for the same degree with the regular students upon completing the remaining requirements. This work can be done in two years, if the candidate has previously made considerable progress in mathematics and science. The culture imparted by classical or other liberal training will be found to have its uses for one engaged in engineering work, and previous discipline of the faculties in exact research will enable the professional student to master more easily the requirements of the course. All the time the student can devote to general studies before taking up specialties will be well spent.

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* For explanation of the term Hour of Credit see page 36, and for further information in regard to the courses prescribed for graduation, see pages 38 to 48.

A choice between the four courses in engineering need not be made before the end of the first year.

GENERAL REQUIREMENTS.

The *general requirements* are as follows: —

In French and German: fifteen hours, viz.: Courses A, B, C, in one language, and Courses D, E, in the other.

In English: Course 1, *1a*.

In Mathematics: Courses 1, 2, 3, 4.

In Physics: Courses 1, 2.

In Chemistry: Course A.

In Drawing: Courses 1, 4, 5.

In Shop Practice: Courses *1a, 2a*.

In Mechanical Engineering: Courses 2, 4.

SPECIAL REQUIREMENTS.

The *special requirements* in the several courses are as follows: —

1. *In Civil Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Civil Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows: —

In Mathematics: Course 6.

In Physics: Course 3*c*.

In Mineralogy: Course 1.

In Geology: Course 12.

In Astronomy: Course 4.

In Drawing: Course 14.

In Surveying: Courses 1, 2, 3, 5.

In Civil Engineering: Courses 3, 4, 5, 6, 7, 8, 9, 15.

In Mechanical Engineering: Course 15.

In Electrical Engineering: Course 4*b*.

In Elective Studies, taken in the department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all one hundred and thirty Hours of Credit.

2. *In Mechanical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Mechanical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows: —

In Mathematics: Course 6.

In Physics: Course 3*c*.

In Metallurgy: Course 1.

In Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.

In Surveying: Course 4.

In Civil Engineering: Courses 3, 5, 9.

In Mechanical Engineering: Courses 1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.

In Electrical Engineering: Course 4*b*.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

3. *In Electrical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Electrical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows: —

In Mathematics: Course 6.

In Physics: Course 3*b*.

In Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.

In Civil Engineering: Courses 3, 5.

In Mechanical Engineering: Courses 5, 6, 7.

In Electrical Engineering: Courses 1, 2, 3, 4*a*, 5, 6, 7, 8.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts: an amount sufficient to secure *one hundred and thirty Hours of Credit.*

4. *In Chemical Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Chemical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows: —

In Physics: Course 3*c*.

In Chemistry: Courses B, C, D, E, I, L, M, N.

In Metallurgy: Course 1.

In Surveying: Course 4.

In Mechanical Engineering: Coures 6, 7.

In Electrical Engineering: Course 4b.

In Elective Studies, taken in the Department of Engineerin in the Department of Literature, Science, and the Arts: an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

5. *In Marine Engineering.*

To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Marine Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows: —

In Mathematics: Course 6.
In Physics: Course 3*c*.
In Shop Practice: Courses 1*b*, 3*a*, 4*a*, 4*b*.
In Civil Engineering: Courses 3, 5, 9.
In Mechanical Engineering: Courses 1, 5, 6, 9, 11, 13.
In Electrical Engineering: Course 4*b*
In Naval Architecture and Marine Engineering: Courses 1, 2, 3. 4. 5, 6, 7, 8.
In all, 130 hours.

Or the student may take the civil or electrical course for three years and do the work stated on page 53 for the fourth year.

GRADUATE COURSES.

The Degree of Master of Science.

A candidate for the degree of Master of Science in this Department must have previously received the engineering degree of Bachelor of Science from this University, or, if graduated elsewhere, must satisfy the Faculty that he possesses equivalent attainments.

He must choose a *major* subject, which shall occupy one half of his time, from the work given in this Department, and two *minor* subjects, each to occupy one fourth of his time, to be selected from any work open to engineering students; all of the work, however, shall be subject to the approval of the Faculty. Study and residence for not less than one year will be required. Among the courses described on previous pages, the following are arranged primarily for graduates: —

In Physics: Courses 7, 10, 16.
In Civil Engineering: Courses 11, 12, 13, 14.
In Mechanical Engineering: Courses 16 to 23, inclusive.
In Electrical Engineering: Course 9.
In Naval Architecture and Marine Engineering: Courses 9, 10, 11, 12.

If a candidate for the degree of Master of Science desires to *have his* work count towards the degree of Civil Engineer, Mechanical Engineer, or Electrical Engineer, the major subject must be taken in the course in which he took his bachelor's degree, and he must submit a satisfactory thesis before such degree as Engineer will be conferred.

The Degrees of Civil Engineer, Mechanical Engineer, and Electrical Engineer.

The conditions on which the degree of Civil Engineer, as an advanced degree, is conferred are as follows: —

The degree of Civil Engineer may be conferred upon Bachelors of Science of this University, who have taken the degree for a course in civil engineering, if they furnish satisfactory evidence that they have pursued further technical studies for at least one year, and, in addition, have been engaged in professional work, in positions of responsibility, for another year. The first of the above requirements may be satisfied by pursuing at the University, under the direction of the Faculty, a prescribed course of study for an amount of time, not necessarily consecutive, equivalent to a college year. If the candidate does not reside at the University, his course of study must be approved in advance by the professor of civil engineering, and he must prepare a satisfactory thesis on some engineering topic, to be presented, together with a detailed account of his professional work, one month at least, before the date of the annual Commencement at which he expects to receive the degree.

The condition on which the degrees of Mechanical Engineer, and Electrical Engineer, as advanced degrees, are conferred upon Bachelors of Science of this University who have taken the degree for a course in mechanical engineering, or electrical engineering, are analogous in character and in amount to those given above for the degree of Civil Engineer.

UNIVERSITY OF MICHIGAN

UNIVERSITY BULLETIN

NEW SERIES, VOL. V, NO. 13, AUGUST, 1904

Department of Engineering

GENERAL ANNOUNCEMENT, [illegible]

[illegible]

[illegible]

UNIVERSITY OF MICHIGAN

Department of Engineering

GENERAL ANNOUNCEMENT
1904-1905
AND
CATALOGUE OF STUDENTS
FOR
1903-1904

ANN ARBOR, MICH.
PUBLISHED BY THE UNIVERSITY
1904

CALENDAR

	1904.	
Feb.	12-13	Examination for Admission.
Feb.	15.	Second Semester Begins.
April	15.	(Evening.) Recess begins, ending April 25 (evening).
June	21.	Class Day.
June	22.	Alumni Day.
June	23.	Commencement in All Departments.
June	24 to Sept. 26.	Summer Vacation.
June	27 to Aug. 5.	Summer Session of the Department of Engineering and of the Department of Literature, Science, and the Arts.
Sept.	21 to 24	*Examination for admission to the Department of Engineering.*
Sept.	27.	First Semester Begins in All Departments.
Nov.	—	Thanksgiving Recess of three days, beginning Tuesday evening.
Dec.	22.	(Evening.) Holiday Vacation begins.
	1905.	
Jan.	10.	Exercises resumed after Holiday Vacation.
Feb.	10.	(Evening.) First Semester Closes.
Feb.	10-11.	*Examination for Admission.*
Feb.	13.	Second Semester Begins.
April	14.	(Evening.) Recess begins, ending April 24 (evening).
June	22.	Commencement in All Departments.

1904

	Sunday.	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.
JAN.						1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
	31						
FEB.		1	2	3	4	5	6
	7	8	9	10	11	12	13
	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
	28	29					
MAR.			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30	31		
APRIL.						1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30

	Sunday.	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.
MAY.	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
	29	30	31				
JUNE.				1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
	26	27	28	29	30		
JULY.						1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
	31						
AUG.		1	2	3	4	5	6
	7	8	9	10	11	12	13
	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
	28	29	30	31			

	Sunday.	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.
SEPT.					1	2	3
	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	
OCT'R.							1
	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30	31					
NOV.			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30			
DEC.					1	2	3
	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31

1905

	Sunday.	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.
JAN.	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
	29	30	31				
FEB.				1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
	26	27	28				
MAR.				1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
	26	27	28	29	30	31	
APRIL.							1
	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30						

	Sunday.	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.
MAY.		1	2	3	4	5	6
	7	8	9	10	11	12	13
	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
	28	29	30	31			
JUNE.					1	2	3
	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	
JULY.							1
	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30	31					
AUG.			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30	31		

	Sunday.	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.
SEPT.						1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
OCT'R.	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
	29	30	31				
NOV.				1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
	26	27	28	29	30		
DEC.						1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
	31						

Board of Regents

JAMES B. ANGELL, LL.D.,
PRESIDENT.

		Term Expires
HON. ARTHUR HILL,	*Saginaw,*	Dec. 31, 1905
HON. CHARLES D. LAWTON,	*Lawton,*	" 1905
HON. HENRY S. DEAN,	*Ann Arbor,*	" 1907
HON. LEVI L. BARBOUR,	*Detroit,*	" 1907
HON. FRANK W. FLETCHER,	*Alpena,*	" 1909
HON. HENRY W. CAREY,	*Manistee,*	" 1909
HON. PETER WHITE,	*Marquette,*	" 1911
HON. LOYAL E. KNAPPEN,	*Grand Rapids,*	" 1911

JAMES H. WADE,
SECRETARY.

HARRISON SOULE,
TREASURER.

HON. DELOS FALL,
SUPERINTENDENT OF PUBLIC INSTRUCTION.
(Office at Lansing.)

Members of the Faculty

AND OTHER OFFICERS*

JAMES BURRILL ANGELL, LL.D., President.
South University Avenue.

ALBERT BENJAMIN PRESCOTT, M.D., LL.D., *Director of the Chemical Laboratory, Professor of Organic Chemistry, and Dean of the School of Pharmacy.* 734 South Ingalls Street.

MORTIMER ELWYN COOLEY, M.E., *Professor of Mechanical Engineering and Dean of the Department of Engineering.*
314 North Ingalls Street.

CHARLES SIMEON DENISON, M.S., C.E., *Professor of Stereotomy, Mechanism, and Drawing.* 502 East Huron Street.

HENRY SMITH CARHART, LL.D., *Professor of Physics and Director of the Physical Laboratory.* 521 Monroe Street.

RAYMOND CAZALLIS DAVIS, A.M., *Librarian.*
521 Church Street.

OTIS COE JOHNSON, Ph.C., A.M., *Professor of Applied Chemistry.* 730 South Thayer Street.

JOSEPH BAKER DAVIS, C.E., *Professor of Geodesy and Surveying and Associate Dean of the Department of Engineering.* 731 South Ingalls Street.

ASAPH HALL, Jr., Ph.D., *Professor of Astronomy and Director of the Observatory.* 922 Olivia Avenue.

ISRAEL COOK RUSSELL, C.E., LL.D., *Professor of Geology.*
1703 Hill Street.

FRED NEWTON SCOTT, Ph.D., *Professor of Rhetoric.*
1351 Washtenaw Avenue.

EDWARD DeMILLE CAMPBELL, B.S., *Professor of Chemical Engineering and Analytical Chemistry.* 1555 Washtenaw Avenue.

ALEXANDER ZIWET, C.E., *Professor of Mathematics, in charge of Mathematics in this Department.*
644 South Ingalls Street.

HERBERT CHARLES SADLER, Sc.D., *Professor of Naval Architecture.* 523 East Madison Street.

GARDNER STEWART WILLIAMS, C.E., *Professor of Civil Engineering.* 1503 Washtenaw Avenue.

GEORGE WASHINGTON PATTERSON, Ph.D., *Junior Professor of Electrical Engineering.*
814 South University Avenue.

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*In this list are included the names of a few officers and instructors with whom engineering students may have occasion to confer.

JOHN OREN REED, PH.D., *Junior Professor of Physics.* 907 Lincoln Avenue.

MOSES GOMBERG, Sc.D., *Junior Professor of Organic Chemistry.* 841 East University Avenue.

JOHN ROBINS ALLEN, M.E., *Junior Professor of Mechanical Engineering.* 226 South Ingalls Street.

JOSEPH LYBRAND MARKLEY, PH.D., *Junior Professor of Mathematics.* 1320 South University Avenue.

KEENE FITZPATRICK, *Director of the Waterman Gymnasium.* 719 East University Avenue.

WILLIAM LINCOLN MIGGETT, B.S., *Superintendent of Engineering Shops.* 432 Hamilton Place.

CLARENCE GEORGE WRENTMORE, C.E., *Assistant Professor of Descriptive Geometry and Drawing.* 933 Forest Avenue.

HENRY CLAY ANDERSON, M.E., *Assistant Professor of Mechanical Engineering.* 331 East Jefferson Street.

JAMES WATERMAN GLOVER, PH.D., *Assistant Professor of Mathematics.* 1312 Geddes Avenue.

ALBERT EMERSON GREENE, PH.B., B.S., *Assistant Professor of Civil Engineering.* 415 East William Street.

WILLIAM HENRY WAIT, PH.D., *Assistant Professor of Modern Languages, in charge of Modern Languages in this Department.* 904 Olivia Avenue.

HERBERT JAY GOULDING, B.S., *Assistant Professor of Descriptive Geometry and Drawing and Secretary of the Engineering Faculty.* 904 Lincoln Avenue.

ALFRED HOLMES WHITE, A.B., *Assistant Professor of Chemical Technology.* 1017 Hill Street.

WILLIAM SYLVESTER HAZELTON, A.B., B.S., *Assistant Professor of Mechanical Engineering.* 1003 Packard Street.

ALFRED C. LANE, PH.D., *Lecturer on Economic Geology.*

*Instructors and Assistants

GEORGE OSWIN HIGLEY, M.S., *Instructor in General Chemistry.* 928 Olivia Avenue.

WILLIAM HENRY BUTTS, A.M., *Instructor in Mathematics.* 919 Oakland Avenue.

BENJAMIN FRANKLIN BAILEY, A.M., *Instructor in Electrical Engineering.* 319 East William Street.

ALICE LOUISE HUNT, *Instructor in Drawing.* 1328 Washtenaw Avenue.

EDWARD BRIND ESCOTT, M.S., *Instructor in Mathematics.* 718 Monroe Street.

WILLIAM MARSHALL, M.S., *Instructor in Mathematics.* 1015 Vaughn Street.

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*Additional Assistants are to be appointed as the work may demand.

*COLMAN DUDLEY FRANK, A.M., *Instructor in French and Spanish.* 718 Monroe Street.

HARRISON McALLISTER RANDALL, PH.D., *Instructor in Physics.* 1220 Prospect Street.

ROYAL ALBERT ABBOTT, A.M., *Instructor in English.* 718 Geddes Avenue.

JOHN WILLIAM SCHOLL, A.M., *Instructor in German.* 1017 Vaughn Street.

LYMAN FOOTE MOREHOUSE, B.S., *Instructor in Physics.* 923 Greenwood Avenue.

FREDERICK CHARLES WILSON, B.S., *Instructor in Descriptive Geometry and Drawing.* 912 Forest Avenue.

WILLIAM GABB SMEATON, A.B., *Instructor in Chemical Engineering.* 109 Michigan Avenue.

ROY ROMANZO PECK, A.B., *Instructor in French.* 503 East Madison Street.

CARL CLIFTON TARBOX, A.B., *Instructor in Rhetoric.* 534 South State Street.

GEORGE MILLER BARTLETT, B.S., *Instructor in Descriptive Geometry and Drawing.* 216 South Fifth Avenue.

HOWARD B. MERRICK, B.S., *Instructor in Surveying.* 928 Church Street.

PETER FIELD, PH.D., *Instructor in Mathematics.* 317 East Ann Street.

ARCHIE BURTON PIERCE, PH.D., *Instructor in Mathematics.* 707 Church Street.

THEODORE RUDOLPH RUNNING, PH.D., *Instructor in Mathematics.* 935 Greenwood Avenue.

ARTHUR WHITMORE SMITH, PH.D., *Instructor in Physics.* 1108 East Ann Street.

EDWARD MILTON BRAGG, B.S., *Instructor in Marine Engineering and Naval Architecture.* 715 Twelfth Street.

HENRY WILLIAM DUBEE, A.M., *Instructor in German.* 804 Monroe Street.

JAMES PYPER BIRD, A.B., *Instructor in French.* 725 Twelfth Street.

VERNER LEE PAGE, B.S., *Instructor in Descriptive Geometry and Drawing.* 1211 Willard Street.

JOSEPH ALDRICH BURSLEY, B.S., *Instructor in Mechanical Engineering.* 604 East Madison Street.

FREDERICK J. MENGER, A.M., *Instructor in German.*

JOHN W. BRADSHAW, PH.D., *Instructor in Mathematics.*

†——————; ——., *Instructor in Mathematics.*

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*Absent on leave.

†Vacancy to be filled.

*————————, ————., *Instructor in Civil Engineering.*

*————————, ————., *Instructor in Mechanical Engineering.*

*————————, ————., *Instructor in Machine Design and Assistant to the Superintendent of Shops.*

HOBART HURD WILLARD, A.B., *Assisant in Analytical Chemistry.* 644 East University Avenue.

HERMAN WILLIAM MARCH, *Assistant in Astronomy.* 421 Church Street.

KARL WILHELMJ ZIMMERSCHIED, A.B., *Assistant in Quantitative Analysis.* 402 South Observatory Street.

FRANK LAWRENCE COOPER, B.S., *Assistant in Physics.* 616 Church Street.

WILLIAM D. HENDERSON, A.B., *Assistant in Physics.* 812 Mary Street.

ELMER EDWIN WARE, *Assistant in Chemical Technology.* 533 East Ann Street.

JAMES ARTHUR BROWN, *Assistant in Mechanical Engineering.* 802 Monroe Street.

GEORGE GOTTLIEB STROEBE, Ph.B., *Assistant in Descriptive Geometry.* 1412 Geddes Avenue.

MORTIMER COOLEY NICHOLS, *Assistant to the Associate Dean.*

MARK HARRIS GREGG, B.S., *Assistant in Mechanical Engineering.* 311 Thompson Street.

*————————, ————., *Assistant in Mechanical Engineering.*

*————————, ————., *Assistant in Mechanical Engineering.*

*————————, ————., *Assistant in Physics.*

Instructors and Assistants in the Engineering Shops

ROBERT ALEXANDER WINSLOW, *Instructor in the Foundry.* 947 Wall Street.

HORACE TRAITON PURFIELD, *Instructor in Carpentry and Pattern-making.* 634 South Twelfth Street.

WILLIAM ROBERTSON McDONALD, *Instructor in Forging.* 1114 East University Avenue.

HARRY MANN COBB, *Instructor in the Machine Shop.* 524 Hill Street.

WALTER CLIFTON WILLARD, *Instrument Maker.* 715 South Twelfth Street.

ALONZO SIMMONS BERRY, *Assistant in Carpentry.* 929 Olivia Place.

CLAIR B. OWEN, *Assistant in the Machine Shop.* 606 South Thayer Street.

WILLIAM HOLMES, *Assistant in the Forge Shop.* 426 Hill Street.

GEORGE GARFIELD BULL, *Assistant in the Foundry.* 1036 Wall Street.

DON BYRON WEBSTER, *Assistant to the Superintendent.* 605 Edwin Street.

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*Vacancy to be filled.

Department of Engineering

GENERAL INFORMATION

The University of Michigan is a part of the educational system of the State, and derives from the State, in one way or another, the greater part of its revenue. The University comprises the Department of Literature, Science, and the Arts, and six professional schools, each of which has its own Faculty and issues each year a separate departmental announcement. The various Faculties include about two hundred officers of instruction, beside nearly one hundred assistants, some of whom participate in the work of teaching. Thirty-nine hundred and fifty-seven students, representing all the States and Territories and many foreign countries, are in attendance.

In the legislative act under which the University was organized in 1837, provision was made for instruction in engineering. There are few older technical schools in the United States. Work was begun in this line in 1853, and the first degrees were conferred in 1860. The engineering courses were included in the Department of Literature, Science, and the Arts, until the close of the collegiate year 1894-95. At that time the Department of Engineering was established by the Board of Regents.

This Department has enrolled at present eight hundred and twenty-three students, pursuing work in different engineering lines. In this number are not included those studying chemistry and other branches of science.

Persons who wish to become professional engineers are offered here thorough courses of study in civil, mechanical, electrical, chemical, and marine engineering, and naval architecture. The work extends through four years, and leads to the degree of Bachelor of Science. The degrees of Master of Science, Civil Engineer, Mechanical Engineer, and Electrical Engineer are given for graduate work. The aim of the department is to lay a foundation of sound theory, sufficiently broad and deep to enable its graduates to enter understandingly on the further investigation of the several specialties of the engineering profession; and at the same time to impart such a knowledge of the usual professional practice as shall make its students useful in any position to which they may be called. While the adaptation of theory to practice can be thoroughly learned only by experience, there are many matters in which the routine work of an engineering field party, office, or drafting room can be carried out on a greater or less scale in a training school. *The technical branches are under the direct care of those who have had professional experience as well as a full scientific training.* The instructors who have the several branches in charge aim to fit the students, as far as possible, for the requirements of active practice.

The chemical engineering course is designed to meet the demand of manufacturers for men capable of intelligently directing manufacturing processes and handling machinery. To this end sufficient chemistry is introduced into the course to enable the graduate to act as his own chemist on most occasions. The instruction includes thorough laboratory drill in qualitative and quantitative analysis, courses in organic chemistry, chemical technology, metallurgy, and a special laboratory course in connection with some chosen manufacturing industry. The engineering studies are, in the main, those required for the course in mechanical engineering; the student gains a knowledge of the construction and use of machinery, and has practical drill in the drawing rooms and shops; but the chemical studies indicated above take the place of the advanced mathematics and the higher work in engineering design.

The work for the first two years is the same for all students. At the end of the second year the student makes his choice to continue in the civil engineering, the mechanical engineering, the electrical engineering, the chemical engineering, or the marine engineering course. The Order of Studies, given in §§ 113-119, is the one recommended by the Department; and the days and hours assigned to the different exercises each year in the Special Program are planned to avoid conflicts. A student can, however, deviate from this printed order, if his preparation for a given study meets the requirements prescribed by the instructor, and if he assumes all risk of interference of hours in subsequent semesters.

No marked distinction between first year, second year, etc., is made; but a student is recommended for a particular degree when he has successfully completed the requirements for the same, as laid down in §§ 120-126.

The academic year extends from the Tuesday preceding the last Wednesday in September to the Thursday preceding the last Wednesday in June (September 27, 1904, to June 22, 1905). The summer session, between the student's third and fourth years, extends six weeks from the Monday following Commencement, June 27 to August 5, 1904. See §§ 114-118.

The Department of Engineering considers that the merits of the course of study and work prescribed for its students can be judged fairly by the professional success of its graduates. Copies of a Register of Alumni, classes 1860 to 1898 inclusive, published in 1899, and showing positions held since graduation, can be obtained on application until the edition is exhausted.

Copies of the University Calendar describing the different Departments, and containing a catalogue of all the students, will be mailed by James H. Wade, Secretary of the University, on request.

REQUIREMENTS FOR ADMISSION TO THE DEPARTMENT OF ENGINEERING

[For admission to advanced standing, see §10-11.]
[For admission of students not candidates for a degree, see §12.]

1. Candidates for admission must be at least sixteen years of age, and must present satisfactory evidence of good moral character. They must bring credentials from

their last instructor, or from the last institution with which they have been connected.

Unless admitted on diploma from an approved school (see §14), any student who desires to become a candidate for a degree must pass examinations in the following subjects:

English Language:—*Three years.*
    Grammar.
    Composition and Rhetoric.
    Reading of Classics.
English Literature:—*One year.*
Mathematics:—*Three years.*
    Algebra.
    Geometry.
Trigonometry:—*One-half year.*
Physics:—*One year.*
Chemistry:—*One year.*
History:—*Two years.*
    General, or Mediæval and Modern.
    United States History and Government.
French:—*Two years.* }
German:—*Two years.* } One of these.
Latin:—*Two years.* }
Botany:—*One-half year.* }
Physical Geography:—*One-half year.* } One of these.
Astronomy:—*One-half year.* }

Each of the above subjects to be pursued through the number of years indicated, with not less than four recitation periods each week.

For a detailed description of these subjects see § 2.

Before entering upon the examination each applicant must present his credentials to the Dean of the Department at his office in the Engineering Building.

Certificates from schools other than those officially examined and approved by the University, as specified in § 14, will not excuse applicants from admission examinations, unless such certificates be accompanied by satisfactory evidence that the school issuing them is equal in grade to the approved schools.

Students who have satisfied the requirements for admission to the Department of Literature, Science, and the Arts are admitted to this department, but must make up their deficiencies in *plane trigonometry* and *science,* if such deficiencies exist. These requirements are: English, *three* units, as below; Mathematics, *three* units, as below; Physics, *one* unit; and *eight* units optional, as stated in the list of requirements for admission to the Department of Literature, Science, and the Arts.

A unit is a subject of study pursued through a school year, with not less than four recitation periods each week.

All entrance conditions must be removed by the beginning of the second year of residence.

ADMISSION OF CANDIDATES FOR A DEGREE

2. The subjects on which applicants for admission to any of the courses leading to a degree in engineering will be examined are as follows:

English Language.—Three units: *Grammar.*—In the examination for admission selections for analysis and parsing will be set, arranged to test the applicant's knowledge of the leading facts of English Grammar. To meet this requirement, a review of the subject should be had during the last year of the preparatory course.

Composition and Rhetoric.—The purpose of the examination in composition is to test the applicant's ability to write good English. To this end he will be asked to write two essays of not less than two hundred words each, one upon a subject drawn from the books mentioned below, and the other upon a subject drawn from his experience or observation. The language of these essays must be grammatical and clear. The spelling, punctuation, and capitalizing must be correct. The applicant must show ability to discriminate in the use of words, and to construct well-organized sentences and paragraphs. A topical outline should accompany each essay.

As preparation for this requirement, sustained and regular practice in writing is earnestly recommended. The student should prepare numerous written exercises throughout the four years of the high school course, and a sufficient number of these exercises should be corrected by the teacher and revised by the student to secure the desired accuracy. The subjects upon which the student writes should not be drawn exclusively from literature; a considerable proportion of them should be taken from the student's every day experience; and topics should be so distributed as to give proper training in the various types of discourse, namely, description, narrative, argument, and exposition. The student should be grounded in the essentials of rhetoric, but those principles should receive emphasis which are most likely to be of service to him in his practice in writing, such as the principles of sentential structure, paragraphing, and the outlining of the essay. The correction of stock specimens of bad English is not recommended, and will form no part of the entrance requirement.

The titles of the books from which subjects for compositions will be chosen in the years named, are here given. The applicant should make himself familiar with the plot, incidents, and characters of each work. Equivalents will be accepted.

1904 and 1905. Shakespeare's *Merchant of Venice, Julius Caesar,* and *Macbeth*; Milton's *Lycidas, Comus, L'Allegro,* and *Il Penseroso*; Burke's *Conciliation with the Colonies;* Macauley's *Essays on Milton and Addison;* The Sir Roger de Coverley Papers in *The Spectator;* Goldsmith's *The Vicar of Wakefield;* Coleridge's *The Ancient Mariner;* Scott's *Ivanhoe;* Carlyle's *Essay on Burns;* Tennyson's *The Princess;* Lowell's *The Vision of Sir Launfal;* George Eliot's *Silas Marner.*

Reading of Classics.—In addition to the books just named, it is expected that several other English Classics will be read each year. These readings should be connected, in reasonable measure, with the lives and characters of the authors read and with the history of their times. A good knowledge of the chronological order and of the leading characteristics of the leading modern English writers should be aimed at. Care should be taken not to overload the text of these classics with a mass of irrelevant and petty learning. Many of the "school classics" now in use are over-edited.

It is recommended that in connection with the reading of classics the memorizing of notable passages, both in prose and poetry, should form a regular exercise throughout the whole preparatory period. This is all-important for the development of a correct taste in language and literature.

3. **English Literature.**—The unit in this subject is intended tc cover one year's work in addition to the three prescribed units of English above. Stopford A. Brooke's English Literature (edition of 1900), or any other manual, may be used for an outline of the subject. As much time as practicable should be given to the careful reading of representative authors in each period.

4. **Mathematics.***—The three units in mathematics include algebra and geometry, as follows: *Algebra.*—Fundamental Rules,

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*Students entering at the beginning of the second semester (February *13, 1905*) should be prepared in the mathematics of the first semester in *addition* to the other requirements for admission.

Fractions, Simple Equations, Involution and Evolution, the Theory of Indices, and Quadratic Equations, as given in Beman and Smith's Elements of Algebra, or an equivalent in other authors.

Geometry.—Plane, Solid, and Spherical Geometry as given in Beman and Smith's Plane and Solid Geometry, or an equivalent in other authors.

Trigonometry.—Plane Trigonometry as given in Murray's or Wentworth's Trigonometry, or an equivalent in other authors.

N. B.—It is very desirable that High Schools whose graduates are received on diploma arrange their courses so as to include a portion of both Algebra and Geometry in their last preparatory year. Students who do not come from diploma schools should take a similar review if they expect to succeed in the study of mathematics in the University.

5. **French, German, or Latin.**—Two units. Applicants may offer French, German, or Latin, one of these three languages being required. It is expected that at least two years will be given to preparation in the language offered. The requirements in each are as follows:—

French.—The whole subject of French Grammar. The applicant will be expected to read at sight easy French, and to translate correctly into French simple English sentences. The first year ought to be spent chiefly on the grammar and easy reading; and the second devoted to reading good modern French, accompanied by grammatical analysis and exercises in writing. The texts read should be chiefly narrative and conversational prose; modern, rather than classic, dramas should be read.

German.—The applicant should be able to pronounce German correctly and to take part with reasonable correctness and facility in a simple conversation upon some topic drawn from the applicant's preparatory work. He should also be thoroughly familiar with the every-day facts of the grammar, and be able to put illustrative English phrases into German, and to translate at sight a passage of fairly easy prose.

Latin.—Jones's First Latin Book, or an equivalent amount in any other introductory text-book, four books of Cæsar's Gallic War, and one of the orations of Cicero.

Advanced credit may be secured for one or two years of German or French study in excess of the two years required for admission; and also if Latin and German or Latin and French are offered, advanced credit is given for the modern language, one year's study being deemed equivalent to Course 1, and a second year's study to Course 2. §§ 94-95.

6. **Physics.**—One unit. An amount represented by Carhart and Chute's Elements of Physics, to which one year should be devoted. Laboratory *work in* Physics is earnestly advised, though not required.

7. **Chemistry.**—One unit. The requirement is intended to cover one year's work. As a text-book, Freer's Elementary Chemistry, or an equivalent amount of work in Remsen's Introduction to the Study of Chemistry, is recommended. In either case the text should be accompanied by laboratory work.

8. **History.**—Two units. One year's work in General History as presented in such a work as Myers's General History, or one year's work in Mediæval and Modern History, and one year's work in United States History and Government, two years in all. Johnston's History of the United States, McLaughlin's History of the American Nation, Adams' European History, Coman and Kendall's History of England, Larned's History of England are suggested.

9. **Botany, Physical Geography, or Astronomy.**—The applicant shall offer *one* of these subjects. The requirements, intended to cover a half-year's work in each subject, are as follows:—

Botany.—Laboratory work for half a year with occasional recitations and review exercises. The method followed in Spalding's Introduction to Botany, or other modern text-book of similar plan and scope, may serve to indicate the kind of work desired.

Physiography.—Either Dryer's Lessons in Physical Geography or Davis's Physical Geography is recommended as a text-book.

Astronomy.—Newcomb and Holden's Astronomy, Briefer Course, Young's Elements of Astronomy, or an equivalent. A knowledge of the principal constellations is required.

ADMISSION TO ADVANCED STANDING

10. *a.* Graduates of the Department of Literature, Science, and the Arts of this University, or of any other reputable college, are admitted without examination to advanced standing as candidates for a degree in engineering, and are excused from a considerable portion of the general requirements (see § 121). The remaining requirements can be completed in two years, if the student takes as electives, while an undergraduate,* the mathematics required of engineering students (see § 97) and

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*A student enrolled in the Department of Literature, Science, and the Arts, and desiring to elect any work in the Department of Engineering which is not printed in the Announcement of the former Department, must obtain written permission of his own Dean, have it approved by the Dean of the Department of Engineering, and attach that paper to his election *slip.*

Courses 1, 4, and 5 in drawing (see § 104). A knowledge of differential and integral calculus, of analytical mechanics, of elementary drawing, and of descriptive geometry, is needful for the advanced work.

b. Students who have completed at least one year's college work in an approved college, and who bring explicit and official certificates describing their course of study and scholarship, and testifying to their good character, are admitted to advanced standing without examination, except such as may be necessary to determine what credit they are to receive for work done in the college from which they have come.

c. Students who have not completed a year's college work in an approved college, but previously to entering this department of the University have pursued studies beyond those required for admission, may be admitted to advanced standing on passing the regular entrance examinations, and examinations in such undergraduate studies as they may ask to be credited with in advance.

Students entering at the beginning of the second semester, February 13, 1905, and expecting to join the first year's class, should be prepared in the mathematics of the first semester, mathematics 1, advanced algebra and analytic geometry (§ 97), in addition to the other requirements for admission.

11. Rules Relating to Admission to Advanced Standing

a. Any student, whether a candidate for a degree or not, who applies for advanced standing on the conditions stated in paragraphs (*b*) and (*c*) above, must present to the Dean a statement showing the amount of work done in the subjects in which credit is asked.

b. The application for advanced standing should be made to the Dean upon entering the Department. A blank form will be furnished for presentation to the professors in charge of the several subjects named in the blank, and each professor will indicate thereon the amount of credit in his subject to which the applicant is entitled.

Manual training work and drawing pursued in a high school will be recognized for advanced credit, if considered by the instructors in the Department of Engineering equivalent to the work given in that Department. Students desiring advanced standing in drawing must bring all drawings completed previous to entrance. See also § 5.

c. Credits must be secured before November 1 or (if the student be matriculated at the beginning of the second semester) before March 15.

d. No credit will be given for advanced standing after the dates named in (*c*).

e. An account once closed cannot be reopened without special permission of the Faculty. See § 91.

ADMISSION OF STUDENTS NOT CANDIDATES FOR A DEGREE

12. All applicants under twenty-one years of age must pass the regular entrance examinations, or bring the graduation certificates described in §14; hence they will, on admission, be enrolled as regular students.

However, to afford an opportunity for persons of mature age, practicing engineers, teachers or others, to take up a few subjects offered in the Department, and to reside at the University a limited time, without becoming regular students, it is provided that persons over twenty-one years of age who desire to pursue studies in this department, and do not desire to become candidates for a degree, may be admitted on the following conditions:

a. They must show that they have a good knowledge of English, and are otherwise prepared to pursue profitably the studies they may desire to take up. Every applicant ought to have the training received in a good high school; and a knowledge of *English language, algebra, geometry, physics,* and *chemistry,* equivalent, at least, to that prescribed in the requirements for admission, will be necessary.

b. Should a student who enters under the preceding provision (*a*) subsequently become a candidate for graduation, he must pass the regular entrance examination, at least one year previous to the time when he proposes to graduate.

c. Students not candidates for a degree who wish credit for studies pursued before admission are referred to the rules relating to advanced standing given above.

d. Students not candidates for a degree are expected to attend the lectures, recitations, and examinations in the branches prescribed for the regular students, and are required to take enough work to occupy them profitably.

EXAMINATION FOR ADMISSION

13. The principal examinations for admission to the Department of Engineering will be held on Wednesday, Thursday, Friday, and Saturday, September 21-24, 1904. Another opportunity is afforded on February 10-11, 1905; but entrance in September is strongly advised. Applicants will not be examined at any other time except on payment of a special fee of *five dollars.*

As the examination begins at 10 A. M. on Wednesday, it will be necessary for all applicants for admission on examination to present their credentials to the Dean of the Department, at his office, on Monday or Tuesday, September 19 or 20, between the hours of 9 and 5, and receive from him papers admitting to the examination.

The examinations in the several subjects will be in writing, and will be held in Tappan Hall in accordance with the schedule given below.

An applicant who fails in some part of the examination may, at the discretion of the Faculty, be admitted conditionally; but any condition so imposed must be removed at one of the two next regular examinations for admission, and no student who has an admission condition outstanding at the beginning of his second year of residence will be allowed to enter his class until such condition is removed.

SCHEDULE OF EXAMINATIONS FOR ADMISSION IN 1904

	Sept. 21, Wed.	Sept. 22, Thu.	Sept. 23, Fri.	Sept. 24, Sat.	
Botany	10 A. M.	......	......	......	Room 8
History	2 P. M.	......	......	......	Room 8
Geometry	......	8 A. M.	......	......	Room 8
French	......	10 A. M.	......	......	Room 12
German	......	2 P. M.	2 P. M.	......	Room 10
Latin	......	2 P. M.	2 P. M.	......	Room 8
Chemistry	......	4 P. M.	......	......	Room 8
Algebra	......	......	8 A. M.	......	Room 8
English Lit.	......	......	10 A. M.	......	Room 10
Physics	......	......	......	8 A. M.	Room 8
English	......	......	......	10 A. M.	Room 10
Phys. Geo. & Ast.	......	......	......	2 P. M.	Room 8
Trigonometry	......	......	......	4 P. M.	Room 8

SCHEDULE OF EXAMINATIONS FOR ADMISSION, FEB. 1905

	Friday, Feb. 10.	Saturday, Feb. 11.	
Algebra	8 A. M.	......	Room 8
Geometry	8 A. M.	......	Room 8
Trigonometry	8 A. M.	......	Room 8
English Literature	10 A. M.	......	Room 10
Physical Geography and Astronomy	11 A. M.	......	Room 8
German	2 P. M.	......	Room 8
Botany	3 P. M.	......	Room 8
History	4 P. M.	......	Room 8
Physics	......	8 A. M.	Room 8
English Language	......	10 A. M.	Room 10
Latin	......	2 P. M.	Room 8
French	......	3 P. M.	Room 12
Chemistry	......	4 P. M.	Room 8

For rules governing the removal of conditions received on *admission* see § 92.

ADMISSION ON DIPLOMA

14. Students presenting graduation certificates from any of the schools officially approved by the Faculty of the Department of Literature, Science, and the Arts, signed by the superintendent or the principal of the school, are admitted without examination to the Department of Engineering. But if such certificate, though it might admit a student to the Department of Literature, Science, and the Arts, shows any deficiencies in the requirements for admission to the Department of Engineering, as for example, plane trigonometry or chemistry, such deficiencies must be made up, or substitutions secured at the time of entrance. Extra studies may be credited on advanced standing, if the subjects are taught in either of the two departments.

The certificate must state that the student has sustained his examinations in all the studies prescribed for admission to the Department of Engineering, or for the fifteen units of credit prescribed for admission to the Department of Literature, Science, and the Arts, and is recommended for admission to the University. It must be presented to the Dean of the Department within a year and three months after graduation from the school, and the student must then begin his work.

The approved schools of the University of Michigan do not necessarily include those accredited to or affiliated with other Universities or Colleges.

Diplomas and sixty-count academic certificates issued by the Regents of the University of the State of New York are accepted by the Department of Engineering in place of examinations in all the subjects required for entrance which are covered by such credentials, provided not more than fifteen months have elapsed since the applicant graduated from school. A statement from the teacher, giving in detail the work done and the proficiency attained in these subjects, must be submitted by the holder of the credentials.

No other credentials, including pass-cards and certificates, issued by the Regents, are accepted, unless they are presented by the holder *of a Regents' diploma* or sixty-count academic certificate.

FEES AND EXPENSES

15. **Matriculation Fee.**—Every student before entering any department of the University is required to pay a matriculation fee. This fee, which, for citizens of Michigan, is ten dollars, and for those who come from any other State or country, twenty-five dollars, is paid but once, and entitles the student to the privileges of permanent membership in the University.

16. **Annual Fee.**—In addition to the matriculation fee, every student has to pay an annual fee for incidental expenses. This fee is paid the first year of residence at the University, and every year of residence thereafter. Resident graduates are required to pay the same annual fee as undergraduates. The annual fee in the Department of Engineering is, for Michigan students, thirty-five dollars; for all others, forty-five dollars.

An annual fee of ten dollars is required of all graduates who are granted the privilege of pursuing studies for an advanced degree *in absentia.*

The Matriculation Fee and the Annual Fee must be paid *in advance.* No portion of the fees can be refunded, except by order of the Board of Regents, to students who leave the University, during the academic year. A by-law of the Board of Regents provides that no student or graduate shall be allowed to enjoy the privileges of the University until he has paid all fees that are due.

17. Fee for Special Entrance Examination.—An applicant for admission who desires to take the entrance examination at a time not announced is required to pay to the Treasurer a fee of five dollars before permission to take the examination can be granted him.

18. Diploma Fee.—The fee for the diploma given on graduation is ten dollars, and the by-laws of the Board of Regents prescribe that no person shall be recommended for a degree until he has paid all dues, including the fee for diploma.

19. Laboratory Fees.—The required Laboratory courses cost approximately as follows: *Shop Practice.*—In the mechanical and electrical engineering courses, *thirty dollars;* in the civil engineering course, *ten dollars. Physical Laboratory.*—A charge of *one dollar* is made for a course requiring one exercise a week during one semes-

ter, and at the same rate for the longer courses. *Mechanical Laboratory.*—The charge for each course is *five dollars. Chemical Laboratory.*—Students who take laboratory courses in chemistry are required to pay for the materials and apparatus consumed by them. The average cost is about *ten dollars. Camp Fee.*—A fee of *ten dollars* is required of students who take the field work in camp.

The fee required for any course has to be paid before the work of the course is begun.

20. **Summer Session Fee.** § 86.

The total amount of fees paid to the University during the whole four years' course, for matriculation, incidental expenses, materials used, and diploma, is, for Michigan students, from $185 to $210; and for others, from $240 to $265, varying more or less according to the student's actual laboratory expenses.

21. **Other Expenses.**—There are no dormitories and no commons connected with the University. Students obtain board and lodging in private families. Room rent varies from seventy-five cents to two dollars a week for each student. Board varies from two dollars and a quarter to three dollars per week. Clubs are also formed in which the cost of board is somewhat reduced.

Students on arriving in Ann Arbor can obtain information in regard to rooms and board by calling at the office of the Secretary of the University. The Students' Christian Association and the University Y. M. C. A. also actively interest themselves in assisting newcomers to find rooms and boarding places. The University does not undertake to furnish manual labor to students; yet a few find opportunities in the city to meet a portion of their expenses. The student organizations mentioned above do what they can to aid those who are seeking employment.

The Michigan Gas Association continues for the year 1904-5 the support of the Fellowship in Gas Engineering which it has maintained since 1900-1. The annual stipend is five hundred dollars. By the terms of the gift the course of study is in charge of the heads of the departments of instruction in chemical engineering and mechanical engineering. The holder of the fellowship for the year 1903-4 was Samuel Ball, A.B.

There are no scholarships, at present, in the Department of Engineering.

22. **Annual Expenses.**—The annual expenses of students, including clothing and incidentals, are, *on the average,* about three hundred and seventy dollars. By the practice of economy, it is possible to complete the four years for one thousand dollars. Not a few students are enabled to complete their course by withdrawing for a year or two to earn money to carry them through the remaining years.

The following actual case is given of the expenses of a Michigan student in his first year:

Matriculation fee	**$10 00**
Annual fee	**35 00**
Shop-work fees, one course each semester	**10 00**
Drawing instruments	**20 00**
Books and stationery	**25 00**
Room and laundry, at $1.50 per week (might have been reduced by sharing room with another)	**55 00**
Board, 34 weeks, at $2.50	**85 00**
Clothes and incidentals	**30 00**
	$270 00

The matriculation fee is paid but once; the drawing instruments, if well selected, will be servicable for a long time; railroad fares will vary, and are not included.

The annual expenses at the University, with ordinary economy, may be put at from $250 to $300.

RELATION OF STUDENTS TO THE CIVIL AUTHORITIES

23. Students are temporarily residents of the city, and, like all other residents, are amenable to the laws. If guilty of disorder or crime, they are liable to arrest, fine, and imprisonment. A rule of the University Senate provides that, if a student is arrested, or is convicted by the civil authorities, he shall be cited to appear before the Faculty of the department in which he is matriculated, and shall be liable to suspension or expulsion.

THE WORK OF THE DEPARTMENT

24. The studies pursued in the earlier part of the course are practically the same for all engineering students. They comprise, in *Mathematics,* advanced algebra, analytic geometry, and the elements of differential and integral calculus; in *French, German, and Spanish,* the

grammar, and reading of narrative prose and current scientific literature; in *English*, courses in composition and rhetoric; in *Physics*, mechanics, sound, light, heat, electricity, and magnetism; in *Chemistry*, the principles of inorganic chemistry; in *Drawing*, geometrical and mechanical drawing and descriptive geometry; in *Shop Practice*, carpentry, pattern making, and forging.

For the order of studies, see § 112.

The more technical subjects follow in the latter part of the course. Some of these are of equal value to all engineering students, such as analytical and applied mechanics, the strength and resistance of materials, and the metallurgy of engineering metals. Other subjects are adapted to the special requirements of the several courses.

For the order of studies, see §§ 114-119.

The general scope of the courses offered is shown in the following:

25. **English.**—The courses in English are primarily composition courses designed to develop in the student correctness, fluency, and constructive power in the expression of his ideas. Course 1 is concerned with elementary principles and details of style. Course 2, Technical Journalism, is designed in response to a demand for technically trained men fitted, by practice in English, to enter the cataloguing departments of manufacturing concerns, and the editorial rooms of technical publications. The course will furnish practice in review and editorial writing, descriptive cataloguing, and kindred work. Course 3 will vary somewhat from year to year. For 1904-1905 the work will be based upon material drawn from the lives of eminent engineers.

Course 1 is required and must precede other courses. Courses 2 and 3 are elective. § 93.

NOTE.—Students in Course 1 who, during the first six weeks, show exceptional proficiency in English work will be excused altogether from the requirement of Course 1, and will be given work of higher grade.

26. **German, French, and Spanish.**—The aim of the instruction in German and French is to help the student to a reading and

speaking knowledge of those languages. The elementary courses continue throughout one year, and their object is to familiarize the student with the forms and the constructions of the languages and to furnish him with abundant practice in reading and speaking them. As soon as practicable, English as a means of communication between instructor and student is banished from the class room, and the conversation conducted in the language taught. The vocabulary employed is, for the most part, that used in the ordinary intercourse of daily life.

The object of the courses of reading in scientific literature is to acquaint the student with the technical terms and special vocabularies of the various sciences, thus enabling him to consult books and periodicals bearing on his professional work with facility and profit. This reading covers a large range of scientific subjects, such as chemistry, physics (mechanics, sound, light, heat, electricity, and magnetism), geology, and mineralogy, as well as articles on steam and gas engines, hydraulics and hydraulic machinery, and mathematics. Many students read, besides the work assigned for the class room, scientific articles in the numerous German and French periodicals that are constantly coming to the University Library. This ability to read German and French scientific periodicals is of great value to the student in the prosecution of much of his work. In some of the more important courses in the Engineering Department a reading knowledge at least of both German and French is required of the students taking them.

Elective courses are offered for the accommodation and benefit of students who have the time and inclination to carry their language work beyond the limits of the required courses. Of the several electives offered, such courses are given as seem best suited to the needs of those applying for advanced work.

In addition to the extensive scientific vocabulary with which the student becomes acquainted, he is provided with practice in epistolary correspondence and is made familiar with the use of business and commercial forms.

The courses in Spanish are almost exclusively conversational, and are offered chiefly to meet the demands of students looking forward to a professional career in countries where Spanish is the prevailing medium of communication, as in the Philippine Islands, the West Indies, Mexico, and the countries of Central and South America. The aim of the instruction in this department is to give the student acquaintance with and facility in the use of Spanish as it is spoken in the social and commercial world, the vocabulary chosen being that heard and used in ordinary daily life. These courses include as a part of their work considerable practice in business correspondence.

Opportunity for advanced work in Spanish is offered to those students desiring to make themselves specially proficient in this language.

27. Mathematics.—The required work (including theoretical mechanics) is the same for all students of engineering, except those in chemical engineering, and extends through the first five semesters.

It is the object of this course not only to impart to the student the mathematical knowledge requisite for the study of the various branches of engineering, but to train his mind in the methods of precise reasoning and accustom him to the proper application of general principles to particular cases.

The first year is devoted to advanced algebra and to plane and solid analytical geometry. In the first semester of the second year the differential calculus and the beginning of the integral calculus are studied, special stress being laid on the geometrical applications, such as the discussion and tracing of curves. During the second semester of the second year and the first semester of the third year the further study and application of the calculus, including the elements of differential equations, are carried on in close connection with the study of theoretical mechanics, three hours a week being devoted to the latter subject and two hours to the calculus The work in mechanics begins with kinematics, the simplest cases of motion in a straight line and in a curve being discussed and illustrated with numerous examples and problems, then follows a thorough course in statics where geometrical and analytical methods are used side by side; finally, in kinetics, the student is introduced to the important ideas of work and energy and some of the more complicated problems regarding the action of forces are treated with special reference to their application in engineering.

In all these courses much time is devoted to the solution of problems in order to supplement a fair knowledge of the elementary principles of higher mathematics with the necessary facility in applying these principles to concrete cases. The classes are divided into sections as small as practicable, so as to make it possible for the instructor to give his individual attention to the student. § 97.

Models are used to assist the imagination both in geometry and in mechanics.

Students desiring to pursue their mathematical studies further will find a large list of electives among the courses in pure and applied mathematics offered in the Department of Literature, Science, and the Arts.

28. Physics.—The instruction in physics covers a thorough course with the use of trigonometry and extends through an entire year. The first semester is devoted to mechanics, sound, and light; the second to heat, electricity, and magnetism. The subjects are amply illustrated with appropriate experiments accompanying the lectures. An additional short course in the laboratory introduces the student to quantitative methods in the study of physics, and prepares him for the more difficult and exacting work in electrical measurements. § 98.

29. **Chemistry.**—The course in the principles of chemistry, for all students of engineering, consists of lectures, with demonstrations and recitations. It covers brefly the facts regarding the metallic and non-metallic elements, and some attention is given to the method of scientific reasoning. Recent work in electro-chemistry is also touched upon. The students are prepared in this course to take up later the chemical processes involved in metallurgy. § 99.

30. **Drawing.**—A very complete course in mechanical drawing is given, embracing plane projection drawing, isometric drawing, descriptive geometry, and the elementary principles of lettering, coloring, and shading, with original problems executed in the drawing-room. Examples from numerical data are always given when suited to the conditions of the problem in hand. Students in mechanical engineering are required to sketch pieces of machinery, and afterward to make working drawings suitable for use in the shop. The plans of surveys, plane-table work, maps, designs in engineering construction, and the thesis drawings naturally come under this head. Instruction is also given in free-hand drawing, topographical drawing, ornamentation and lettering, shades and shadows, linear perspective, and drawing for stone cutting. The work in drawing occupies the student a part of almost every day throughout the course. § 104.

There are large and well-lighted drawing-rooms in the engineering buildings and in the engineering laboratory. There are also special rooms for blue-printing and a dark room for photography.

31. **Mechanical Practice and Shop Work.**—The aim of the instruction in this department is to make the student, as far as time will permit, acquainted with the best mechanical practice; the instructors in all practical work are men of wide experience, selected for their mechanical skill; and the department attempts to keep in touch with the most improved methods of mechanical construction. All courses are under the direction of the Superintendent of Shops, and instruction is given in the various branches by practical men, skilled in the craft which they teach.

The courses of instruction all begin with a systematic series of graded exercises, to give the student familiarity with the common tools used in the particular branch of work he is pursuing; and in connection with each course, the theory of the process is taught by lectures or by assigned reading. The student thus becomes fitted to execute an ordinary piece of mechanical work and at the same time acquires familiarity with sources of information bearing upon such work. At a later stage in the course the student is taught to apply the principles previously studied in the classroom, and to combine skill and knowledge in the transformation of crude materials into articles which have a market value. § 105.

In *Carpentry and Pattern Making,* after the student has completed the preliminary series of graded exercises, he is set to making and assembling the parts of some complete piece of carpenter or joiner work, and he then devotes the remainder of the time, about three-fifths of the whole, to pattern work. Special stress is laid upon this part of the course. The student shapes, forms, and builds up patterns for castings in iron and brass, allows for shrinkage, makes core boxes, and becomes as familiar as possible, in the time allowed, with all the details of practice. Each class, with the help of the instructors, is expected to make a full set of the patterns needed for the construction of some special piece of working machinery. The first course in carpentry is taken by all the engineering students.

In the *Foundry* the student learns to mould in green sand, in dry sand, and in loam, both for brass and for iron castings. Instruction is given in the making of cores for various purposes, and their use in the moulds; and in the art of selecting and mixing metals so as to produce the kind of material desired, careful attention being paid to the making of composition metals for specific purposes. Each student is required to take part in all of the work about the cupola and the brass furnaces, and to assume his share of their management during the periods of melting and casting.

In the *Blacksmith Shop* the student is required to make forgings from a large variety of irons and steels. In this way he becomes familiar with different kinds and qualities of materials suited for blacksmith work; he learns how to heat, forge, anneal, harden, and temper such tools as are used in machine shops; and he also has practice in soldering and brazing. The object of the course is to enable the student to acquire a certain degree of skill in practice, and at the same time impart to him a knowledge of the principles governing such processes of forging as an engineer is likely to be called upon to direct. This work is required of all regular students.

In the *Machine Shop* the instruction is conducted on the same plan as in the pattern shop. On the completion of the series of graded exercises, the student begins the construction of parts of machines. Each class undertakes the building of one or more simple machines, or pieces of apparatus; and the work is planned in such a way as to give opportunity for learning general shop manipulation. Advanced students are also allowed to elect extra work and to assist the skilled workmen in the construction of larger machines.

A description of the engineering shops is given in § 73.

32. **Manual Training.**—In all the above-described courses advanced work can be taken by students who wish to become specially skilled in certain lines, or who desire to fit themselves for instructors in Manual Training Schools or in shops of that character.

33. **Surveying.** (*a*) *For Students in Civil Engineering.*—The course covers a full academic year, and includes text-book work, lectures, recitations, and field practice. The methods of surveying and computing used in laying out work are explained in detail; each

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student is required to make plats, maps, and the necessary calculations from actual surveys; and instruction is given in the proper care, use, and adjustments of instruments. There is an ample and varied supply of instruments for the use of students.

The classroom instruction embraces the following topics: instruments and their adjustments; surveys for the inclosure and division of land; some account of the United States Land Survey; city surveys and town plats; surveys of lines of communication, such as roads, railways, and canals; hydrography; special surveys for various purposes of construction, such as laying out buildings, culverts, and abutments, and locating bridge piers; and, in general, the elements of all the ordinary operations to be expected in the professional practice of a civil engineer, but without including Land Surveying in the broad sense of the term. The principal text-books used are Johnson's Surveying, Raymond's Surveying, and Searle's Field Engineering. The more important works of reference are also easily accessible to the student. § 106.

The practical work outlined below, and carried on in the fall, early winter, and spring of each year, is intended to cover the elementary operations required in making surveys for engineering works, such as roads, streets, railways, canals, inclosures of land, public improvements, and the laying out of structures on the ground.

The steel tape practice includes linear measurements, ranging lines, measuring and laying-out angles, laying-out circular curves, and making the records and computations pertaining to such work. With the transit and steel tape the student has practice in reading angles; traverse surveying; laying-out circular curves, simple and compound; and running straight lines. He is also required to keep the records and make the calculations connected with such work; to make plats, and to compute areas. The practical work with the level and rod includes simple leveling, check-levels, and profile leveling, together with the necessary field notes and checks. The practice in topography embraces the use of the transit and stadia; plane-table work; and surveying with aid of the camera, including the development of negatives and the printing and mounting of photographs. From the field notes and photographs maps are made by the student. In this connection, also, the student has practice in making blue prints from negatives and from drawings.

During the first six weeks of the following summer vacation (between the third and fourth year) the class goes into camp in a favorable locality as a field party. A survey is made for some line of communication, usually a railroad, including exploration, preliminary and located lines, easements to curves, profile leveling, check levels, profile making, cross-section data, cross-sectioning, transfer of line to plugs near grade points, witnessing, and, in general, the preparation of the line for construction up to the point of beginning excavation. In this connection good field and office records are required; profiles and maps are made; and the necessary computations, including those for earthwork quantities, are worked out.

In addition to the railroad surveying, some other piece of field work is undertaken, the selection being made according to the fitness of the locality, the number and the previous experience of the members of the class, the time, and the weather, the purpose being to fix, by practical application, the principles learned from textbook, lectures, or previous experience. Within the past few years, work of the character indicated below has all been done, though not all in any one year: small triangulation surveys, in which there is considerable reading of angles; compass surveys; shore-line surveys; surveys for special purposes, like town sites, bridge sites, cemeteries, or particular areas of unusual shape; resurveys of the United States Land Survey, including the finding and restoring of lost corners, and the subdivision of sections; contouring; hydrography; gauging of streams; leveling for special purposes, such as mill powers, lake levels, and the determination of the fall of streams; and, in general, any ordinary piece of field work, for which the locality chosen for the camp may afford favorable conditions.

The work in camp also includes office work along the various lines of field work, such as the computation of triangulations; reduction of careful measurements; calculation of earthwork, azimuth, areas, and elevations; mapping; platting; and profile-making. §§ 106, 114.

(*b*) *For Students in Mechanical and Chemical Engineering.*—The student in mechanical or in chemical engineering takes a short course in the use of instruments, which is nearly all practice. He is required to read angles with a transit; to make a traverse; to make steel-tape measurements; to do simple leveling; and to compute and plat an inclosure survey. The aim of the course is to cover the simple manipulations in the ordinary use of surveying instruments, and to qualify the student for such duties in this line as are apt to fall to the mechanical engineer, such as mapping an inclosure, staking out a building and fixing the levels for it, laying out foundations for machines or boilers and establishing the levels for them, lining up shafts, setting water power machinery, and preparing lines for transmission of power by wire-rope, compressed air, or water. § 106.

(*c*) *Other Courses.*—Courses in Land Surveying, the United States Land Survey, the Canadian Survey, and in other specialties are provided, if properly qualified persons present themselves in sufficient number to form classes.

34. **Geodesy.**—For students prepared to undertake the work a course is offered, comprising lectures, reference reading, and written class reports, on geodetic methods in the field with special reference to successful present-day practice. Some consideration is given to notable historical surveys, and constant use is made of reports and standard works of reference. § 106.

35. **Astronomy.**—Practice in the determination of time, latitude, and azimuth is required in the civil engineering course. The

ordinary problems necessary in field work are taken up by each student, who makes for himself a complete series of observations and reduces his own data. Observations are thus made with the sextant for time and latitude, using the stars and the sun; with the surveyor's transit for time, latitude, and azimuth; and with the meridian transit for time and latitude by Talcott's method. A thorough drill is given in the use of astronomical ephemerides and in the making of computations.

As elective courses further instruction is offered in Practical Astronomy, and in the Theory of Least Squares. This last should be taken by all students interested in experimental work. § 101.

36. **Highway Construction.**—A course of lectures and text-book work is given to students of civil engineering, on the construction and maintenance of roads, streets, pavements, and walks. References are made to existing examples and present practice. Byrne's Highway Construction is used as a text-book. § 106.

37. **Municipal Engineering.**—A course of lectures, prescribed reading, and recitations covers the special field of city engineering, points out its connection with, and dependence upon, other branches of engineering work, and shows how to apply the principles of engineering to the modern problems arising in the building and improvement of cities, particular attention being given to sanitary questions. Among the topics treated are streets and their present uses, sewers, waterworks, public franchises, assessments, bridges, building inspection, fires, street lighting, street cleaning, and garbage disposal. The instruction is not intended to be of a technical character, but it aims to set forth the principles that should guide the city engineer in his relation to various matters of public concern, and to supplement and apply to this special field the instruction given in other courses. The course should not be taken by undergraduates before their last year of residence. § 107.

38. **Strength and Resistance of Materials.**—A course of recitations and lectures continuing through the first half-year is devoted to this subject, and is attended by all the engineering students except those pursuing the chemical engineering course. Simple and restrained beams and girders, shafts, pieces under tension, columns and struts are analyzed for different conditions of load; riveted work is computed; the action of the different materials under applied forces, the distribution of stress, and the proper proportions to be given to the different parts and details of structures in order that they may safely fulfil their several functions are carefully studied. Greene's Structural Mechanics is used as a text-book. § 107.

Tests of wood, iron, steel, cement, and other building materials are made in the Engineering Laboratory.

39. **Theory of Structures.**—Roof and bridge trusses, in wood and iron; arches, in wood, iron, and stone; trestles; brick and stone masonry; foundations; tunnels; and, in general, the whole theory of

structures are discussed. In this course Rankine's Civil Engineering is used as a text-book, supplemented by full explanations, additional notes, lectures, examples, and problems, and illustrated by models, photographs, working drawings, and blue-prints. § 107.

40. **Graphics.**—A course of instruction extending through a year is given in the graphical analysis of roof and bridge trusses and arches under steady load, wind pressure, and moving loads. The student is made familiar with both the analytical and graphical methods of treatment, and thus possesses ready proof of the accuracy of his calculations. Greene's Roof Trusses, Bridge Trusses, and Arches are used as text-books. § 107.

The subject of mechanism, also, is given a graphical treatment. § 108.

41. **Hydraulics.**—The laws of the flow of water through orifices and pipes and over weirs; the gauging of streams and rivers; the designing of works for water supply, drainage and sewerage; the laying out of canals; and the subject of river and harbor improvements are treated in this course. The text-book used is Merriman's Hydraulics. § 107.

The work in hydraulics is to be much extended in the near future, and will embrace the development of water supply and storage and hydraulic power plants. The new hydraulic laboratory with its equipment will afford abundant opportunity for practice in the measurement of flow under various conditions, the determination of hydraulic coefficients, and for original investigation. § 75.

42. **Machinery, Prime Movers, and Power Transmission.**—A course of instruction is given in mechanism, or the general principles of machinery, involving the study of gearing, screws, cranks, and levers, and the dynamics of machinery. In the study of prime movers, special attention is given to turbine and other water motors, and to steam engines. In the theory of machine construction, problems involving the strength and design of machines, and the materials used in their construction, and also involving the application of the principles of electricity, are studied at length in connection with such examples as illustrate the best practice. The instruction in power transmission covers the distribution of power by shafts, belts, rope, hydraulic and pneumatic transmission, and the arrangement of shafting and machinery in manufacturing establishments. Practical problems involving the strength of shafting, belting, and gearing are fully treated. Tests are made to determine the efficiency of machines and the value of lubricants. § 108.

43. **Design of Shop Machinery.**—The student is taught to design one or more of the standard machines used in shops. He is shown how to combine his theoretical and his practical knowledge so as to conform to the best mechanical practice. He designs one or more complete machines, and makes a detailed drawing of each

part for shop use. The drawings that possess merit and are carefully worked out are subsequently used in the shops. Instruction is also given in blue-print work. The course is intended in every respect to represent, as far as possible, the operations of actual business. § 108.

44. **Designs in Engineering and Machine Construction.**—Contemporaneously with the study of theory, students are required to work out problems in design. They are furnished with the usual data for a design, and the kind or type of structure or machine is indicated. They are then expected to make the necessary calculations, paying particular attention to proportioning the different parts so as to secure strength, simplicity, and effect, and to present at a specified date complete working drawings, giving full details, accompanied by bills of materials, estimates, and specifications. § 108.

45. **Metallurgy.**—A course of instruction by lectures and recitations is given to mechanical and chemical engineering students upon the subjects of fuel, refractory material, iron, and steel. The lectures are illustrated by charts and drawings of furnaces and appliances used, and by samples of furnace products. § 100. Mechanical engineering students are required to take metallurgy in the summer session between the third and fourth years. § 115.

46. **Mineralogy and Geology.**—The civil engineering students are required to take a brief course in mineralogy, which aims to make them acquainted with the more common minerals, § 102, and a course in the elements of geology. § 103.

Advanced courses in both of these fields are open as electives.

47. **Thermodynamics.**—This course embraces the study of the principles governing the action of heat engines in general, hot-air and gas engines, air compressors, compressed-air engines, and refrigerating apparatus. § 108.

48. **Steam Engineering.**—The work in this branch covers the practical use of steam. Furnaces and boilers are studied with reference to proper combustion of fuel; to securing maximum evaporative efficiency; and to proportioning the parts for strength, durability, and accessability for cleaning and repairs. The care and management of engines and boilers, both in use and out of use, are fully considered. A study is made of the principal steam pumps and pumping engines. Tests are made to determine the value of fuels, quality of steam, and the efficiency of furnaces, boilers, and engines. § 108.

49. **Gas Engines, Compressed Air, and Refrigeration.**—The theory is discussed under thermodynamics. Additional courses are given, covering the application of the theory, mechanical details of construction, and methods of operation. § 108.

50. **Heating and Ventilation.**—A course of lectures and recitations is given covering the theory of heat as applied in heating, the

design and construction of hot air, direct and indirect steam, hot water, and fan systems of heating. Plans are made for different systems, and plants inspected. § 108.

51. **Primary and Storage Batteries.**—Two courses are given combining theory and experimental work, and dealing with the calculation and measurement of electromotive forces, polarization, internal resistance, and efficiency of cells. Several types of storage cells are in constant use. The practical use of batteries in electrical engineering is considered in the courses in distribution of electricity, and telephony and telegraphy. See also the courses in electrical measurements. § 109.

52. **Electrical Measurements.**—This course extends through an entire year, and is devoted to practical work in the laboratory with the most modern apparatus. In addition to exact methods of measuring resistances, electromotive forces, and currents, it includes the calibration of the measuring instruments employed, the determination of capacity in absolute measure, the measurement of inductances, and the determination of the hysteresis curves of iron and steel. § 109.

53. **Dynamo Electric Machinery.** (*a*) *Direct Current Machines.*—The time given to this course is about equally divided between the study of the theory of generators and motors, and the determination in the electrical engineering laboratory of characteristic curves, of the series turns required to compound for constant potential, and of the efficiency of generators and motors. Visits will be made to neighboring power stations. § 109.

Mechanical and chemical engineering students are expected to take this course in the summer session between the third and fourth years. §§ 115-117.

(*b*) *Alternating Current Machinery.*—Two courses are given in which, to the theoretical study of the subject, is added laboratory work with alternators, transformers, synchronous and induction motors, either single phase or polyphase, and the transmission of power between generators and motors, especially two and three phase systems, and the conversion of one into the other. Visits will be made to neighboring power stations. § 109.

With the occupancy of the new engineering building in 1904 the facilities for the courses in dynamo electric machinery will be much increased.

54. **Design of Electrical Machinery.**—Two courses in electrical design give the fundamental principles and illustrate them by numerical calculations of electromagnets, of direct current generators and motors, alternators, transformers, and induction motors. The lecture courses are supplemented by exercises in drawing in which each student makes working drawings to accompany his own designs. Highly satisfactory transformers, two-phase and three-

phase generators, and induction motors have been built by electrical engineering students in the engineering shops. § 109.

55. **Distribution of Electricity.**—This course deals with systems of electrical conductors for the distribution of current for lighting and power, and with the electrical engineering problems which are involved in the distribution of electricity. § 109.

56. **Telephony and Telegraphy.**—This course includes class and laboratory instruction. Visits will be made to neighboring telephone exchanges to inspect different systems. Ample laboratory facilities are provided in the new engineering building to be occupied in 1904. § 109.

57. **Industrial Chemistry.**—Under this head come those courses which treat of chemical processes on a manufacturing scale. The chief subjects are: Fuels; gas; iron and steel; water; the acid, alkali, cement, and glass industries; by-products from coal and wood; starch, glucose, and sugar; fermentation and distillation; fats, oils, and soaps; bleaching and dyeing; tanning; the paper manufacture, etc. § 99; 33, 38, 39.

58. **Structural Arrangements of Ships.**—This course is devoted to the discussion of the practical details relating to the various parts of a ship's structure, such as keels, framing, plating, preparation of working drawings, ordering material, general methods of construction, and Classification Societies' rules. § 111.

59. **Ship Calculations.**—This course consists of a series of lectures and recitations upon the displacement and buoyancy of ships, and includes discussions of rules for determining areas, volumes, center of buoyancy, metacenters, change of trim, tonnage, freeboard, etc. The theory and use of the planimeter and integrator are also discussed. § 111.

60. **Strength of Ships.**—This course includes a general discussion upon the question of strength and resistance of materials, methods of obtaining curves of weights, buoyancy, shearing force, and bending moment upon ships under various conditions of wave support; general and local stresses, and strength of riveted joints. § 111.

61. **Stability of Ships.**—A series of lectures and recitations is devoted to the various methods of obtaining curves of stability, statical and dynamical, of vessels of different types under varying conditions. The geometrical properties of the surface of buoyancy, flotation, etc., are discussed, together with problems relating to the rolling of vessels in still water and in waves. Methods of reducing rolling are illustrated by models in the experimental tank. § 111.

62. **Resistance and Propulsion of Ships.**—Under this heading are treated all questions relating to the resistance of vessels to motion. Surface friction, wave making, eddy resistance, Froude's law of comparison, progressive trials, etc., are discussed and illus-

trated in the experimental tank. Investigations of the action of various forms of propellers, and the analysis of their effect upon the resistance of the vessel are also discussed. § 111.

63. **Ship and Engine Specifications.**—A series of lectures is given which embraces a general discussion of the preparation of specifications. Methods of estimating weights and costs; arrangements of pumping, heating, and ventilation; auxiliary machinery, etc., are also included. In connection with the design of a ship or machinery installation each student is required to prepare a general specification. § 111.

64. **Practical Shipbuilding.**—A course of lectures is given on arrangements of shipyards, methods and sequence of work, preparation of working-plans, specifications, etc. Methods of estimating weights and cost, arrangements for pumping, heating, and ventilation are also discussed. § 111.

65. **Mould Loft Work.**—The course in this subject includes the laying off and fairing a set of lines of the full sized ships; method of obtaining bevels; expansion of various parts of the structure; laying off plating, and preparation of moulds. § 111.

66. **Marine Engineering.**—Under this heading are treated the theoretical and practical considerations governing the design and construction of marine engines and boilers of various types. Details of construction, weight, and space occupied, vibrations, and methods of balancing engines, are also treated, together with the design and arrangement of auxiliary machinery. § 111.

67. **Drawing and Design.**—The above courses are accompanied by work in the drawing room, which will include: Laying off and fairing a set of lines from given offsets; calculations of displacement, center of buoyancy, etc., and plotting results; construction of capacity curves; calculation of change of trim and curves connected therewith; of launching; of strength and determination of curves of weight, buoyancy, shearing forces and bending moments; calculation of stresses; of curves of stability.

Later, the student will work out a design for a vessel to fulfil given conditions, as, for instance, a fast passenger or cargo steamer, cruiser, battleship, torpedo boat, or steam yacht, and will prepare the lines, general arrangement, midship section, and all calculations connected with the above, and if time permit, a complete set of working plans, together with an order form and specification.

In marine engine drawing the student will design a marine boiler with all details, and also a marine engine with as many of the detail plans as possible, and will make all necessary calculations. § 111.

Visits of Inspection. See § 70.
Experimental Tank. See § 77.

EXAMINATIONS

68. Examinations, usually in writing, are held at the end of each semester (§ 129), but the classes are liable to be examined at any time, without notice, on any portion of their previous work.

FACILITIES FOR INSTRUCTION

69. The collections for illustrating the instruction given comprise models, drawings, photographs, lithographs, and blue prints representing trusses, arches, and details of construction in iron, wood, and stone; sections of valves, pumps, and injectors; indicators and gauges; working models in various lines and full-sized machines; working drawings of bridges, engines, dynamos, etc. These collections are receiving additions from year to year, by gift and purchase, and are invaluable to the student.

70. **Visits of Inspection.**—As often as practicable, visits are paid to neighboring manufacturing establishments, to electric light and electric power stations, and to points of engineering interest, for the purpose of acquiring a knowledge of the methods employed in building, in the construction of bridges, machinery, and ships, and the best practice in electrical manufacturing and engineering on a large scale.

Tests of engines and boilers, and of machinery in general, will be made on request, and the profit of such work devoted to extending the facilities of the engineering laboratory. The data of all experiments and tests made are kept in the laboratory records. Tests of materials are also conducted for private parties, and reported upon when desired.

All the laboratory work is on a practical basis, and is done as nearly as possible as it would be done in any well-arranged manufacturing establishment. There is a metallurgical laboratory connected with the chemical laboratory, supplied with assay furnaces and other appliances. The latest and best books on professional subjects are added yearly to the library, where they are accessible to all; and frequent references are made to them in the class room as the various subjects are brought forward.

71. **Physical Laboratory.**—The basement of the physical laboratory is devoted to the experimental work in

heat, electricity, and magnetism. It contains about 4,500 square feet of floor space and is divided into ten rooms. These include a photometry room with blackened walls for testing the candle power of incandescent and arc electric lamps, and a storage battery room.

On the first floor are a commodious lecture room, an apparatus room, three rooms for general laboratory purposes and for the practical work in sound and light, and two rooms for a private laboratory.

The laboratory is supplied with the apparatus from the best American and European makers. In sound, it includes tuning forks and resonators from Koenig, of Paris; in light, a spectrometer with 12-inch divided circle, an ophthalmo-spectroscope from the Geneva Society, an optical bench, with accessories, from Duboscq, a Zeiss focometer, spectrometer, and interferometer, and a polariscope from Schmidt and Haensch, and apparatus suitable for work in the ultra-violet and infra-red spectra.

In heat, mention may be made of standard thermometers, including a set from Haak reading to hundredths of a degree and covering the scale from—5°C. to 105°C., a platinum-rhodium couple, certified by the Reichsanstalt, and accessory apparatus from Siemens and Halske for the measurement of high temperatures, air thermometers, Clement and Desormes' apparatus for measuring the ratio of the two specific heats of a gas, and Regnault's vapor pressure apparatus.

The work in the laboratory is entirely quantitative in character, but provision has been made for illustrating the general principles and laws of physics in the lecture courses.

With the removal of the electrical laboratory to the new engineering building in 1904, the space devoted to the physical laboratory will be materially enlarged and a corresponding increase in facilities will follow.

72. **Chemical Laboratories.**—The chemical laboratories provide for classes in general, analytical, organic, and physical chemistry, in pharmacy, in chemical technology, and in metallurgical assaying. They also provide for original research in the several branches of chemical science and for independent investigations in technology. In the course of the year, classes are formed in forty-six distinct courses of study. In the greater number of these

courses the method of work combines training in laboratory operations with instruction by lectures and conference, these methods being united in one course.

The chemical building contains in all about 37,000 square feet of floor space. Besides the rooms for recitations, storage, administration, etc., the laboratories for students have an area of about 25,000 square feet.

The laboratory of general chemistry is separately organized. Courses in elementary inorganic chamistry, as well as in physical chemistry and the advanced branches of the science are offered; research work both in inorganic and in organic general chemistry is also arranged for a limited number of students. Modern apparatus is on hand for all the varieties of work that are liable to be undertaken, and a well-equipped balance room is provided.

The laboratories of analytical chemistry, organic chemistry, pharmacy, and chemical technology are carried on together. There are separate work rooms for qualitative analysis, quantitative analysis, iron and steel analysis, electrolytic work, pharmaceutical preparations, organic preparations, organic analysis, physiological chemistry, and assaying of ores,—as well as rooms for the weighing-balances and instruments of precision, for gas analysis, and for optical work. The rooms fitted up for chemical technology in various industrial branches have nearly 3,000 square feet of floor space. There are eleven separate rooms for original research, two lecture rooms, and two recitation rooms. In the ventilation of the work rooms the supply of fresh air is enforced by driving fans, and the removal of foul air is effected by draught flues and by electric-motor fans, with which, also, working hoods are connected.

The chemical laboratories are open throughout the college year to all students of the University, and are regularly used by the several departments. They are also open to any person who wishes to pursue special studies therein, provided he complies with the conditions for admission to that department of the University to which the desired special studies properly belong.

Over three hundred students are engaged in these laboratories at the same time, each at a table provided for one worker. During the year from 600 to 700 students complete from one to five courses of study each in the various branches of chemistry. The students engage in chemical work as it is needful for their different purposes —the pursuit of science, or the preparation for teaching, for the several professions applying chemistry, and for the various chemical arts and industries.

73. Engineering Shops.—The engineering shops are in a group of connected buildings, and occupy about 30,000 square feet of floor space.

The *Carpenter and Pattern Shop,* 40 by 127 feet, is equipped with the tools and machinery usually found in a first-class establishment.

One end of the shop contains work-benches and tools needed for hand work in carpentry. The other end contains benches and tools specially adapted for pattern-making. The central portion is occupied by a good variety of wood-working machinery. A lumber and pattern loft, 40 by 120 feet, contains blue-printing apparatus, materials, and a large collection of patterns made by students.

The *Foundry,* 30 by 120 feet, is equipped with cupola and brass furnaces, core-ovens, elevator, crane, blowers, and a supply of small tools and flasks suitable for the kinds of work done. From one to two tons of castings are made weekly.

The *Blacksmith Shop,* 40 by 127 feet, contains twenty-eight modern down-draft forges, together with anvils and tools for doing all kinds of work in hand forging, and machinery for forging by mechanical processes and for working structural shapes in iron and steel. Blast is supplied to the fires by an electrically-driven blower, and the gases are removed and discharged into a brick stack by an exhaust fan electrically driven, which thoroughly ventilates and purifies the atmosphere of the room.

The *Machine Shop,* 40 by 127 feet, contains an assortment of engine-lathes, speed-lathes, turret-lathes, planers, shapers, milling machines, grinding machines, and various tools for working in metal. A well-equipped tool-room is connected with this shop.

In connection with each of these four shops there is a lecture and quiz room, in which are collected models, drawings, charts, diagrams, and books, which are used in the courses of instruction.

The *Instrument Shop,* 20 by 32 feet, contains a number of small lathes and drills, and the tools needed in constructing scientific and other apparatus.

The *Drawing Room,* 32 by 54 feet, is fitted with improved drawing-tables, lockers, and drawing cases for use with classes in workshop drawing and machine design.

The central portion of the building, 32 by 54 feet, contains in the basement a well-ventilated lavatory and locker-room, and on the first floor an engine room with a 10 x 30 Reynolds-Corliss engine, a store-room, and the superintendent's office.

A good part of the equipment has been designed and built in the shops. New machinery is added from time to time by construction or purchase. The entire equipment is used in instructing engineering and other students in the use of tools for working in wood and in metals, and in modern workshop methods. Opportunity is afforded to become familiar with the more common materials and forms of construction used in engineering structures, buildings, and machinery. In all work an effort is made to follow the practice of the best shops.

74. **Mechanical Engineering Laboratory.**—This laboratory is devoted to experimental work in connection with the testing of engines, boilers, pumps, indicators, belting, gearing, lubricants, and strength of materials, and to such original work as can be undertaken with advantage. The work also extends to the testing of engines, boilers, and water-wheels of neighboring mills and electric plants. The Knowles and the Gordon pumping engines at the City Water Works have been fitted up by the company with special reference to the convenience of engineering students in making tests.

The equipment contains, among other things, a 100,000-pound Olsen testing machine; a 2,000-pound cement testing machine; Thurston and Ashcroft oil testing machines; a Stirling boiler for high pressure; a high speed automatic engine; a Corliss engine; a Westinghouse compound engine; a DeLaval steam turbine; a Fairbanks-Morse gas engine; a Meitz and Weiss kerosene engine; a Blake air compressor; a Rider hot-air engine; Wheeler and Wainwright surface condensers; an Alden absorption dynamometer; a Giddings traction recording dynamometer; an Emerson power-scale; several other forms of dynamometers; a large, electrically driven chronograph, built in the laboratory; a 36-foot open mercury column; special apparatus for testing pressure and vacuum-gauges and indicator springs; gauges; indicators; thermometers; pyrometers; tachometers; standard weights; steam pumps and injectors; rotary and centrifugal pumps; water meters; water motors, including a special universal water motor, built in the laboratory, together with pressure tanks and pumps for testing motors; hydraulic rams; waterwheels; air-pumps; blowers; apparatus for making tests on radiators and pipe coverings; apparatus for furnace gas and fuel analysis; and other apparatus having special reference to work of investigation.

The new Engineering building recently erected provides greatly improved facilities for experimental work.

The steam laboratories occupy a space of 60 by 60 feet on the first and second floors of the north wing, with a basement under a part of the ground floor. Adjoining is a boiler house, 34 by 34 feet, having a gallery eight feet wide. It is planned to install in this laboratory as new equipment a multiple expansion engine, a gas engine plant of 100 horse-power, including a gas producer, an Armington-Sims simple engine, a compound steam pump of large capacity, a refrigerating plant, and a high pressure air compressor.

The present older equipment enumerated above will also be installed in the new building.

The boiler room is provided with a Stirling boiler, a Buffalo Forge Co's. direct steam driven induced draft fan, feed water heaters, econometer, weighing tanks and all necessary accessories for boiler testing.

On the west side of the ground floor of the east wing a space 22 by 26 feet has been set apart for testing the physical properties of materials and for a cement-testing laboratory.

On the third floor of the north wing the 100-inch electrically driven ventilating fan for this wing has been installed especially for the investigation of fan heating problems. It is provided with a Reeves Transmission by means of which the speed can be varied from 100 to 400 revolutions per minute. The heaters are so arranged that any number of rows of heating pipes up to thirty-two can be had on either the suction or the blast side of the fan.

This fan is also provided with a discharge pipe leading into the mould loft by means of which experiments can be made to determine air pressures and resistances on bodies of different forms at velocities varying from 15 to 100 feet per second. This apparatus, while available for heating purposes, was designed with especial reference to experimental work. It was donated by the Buffalo Forge Co., Buffalo, N. Y., who have spared neither pains nor expense in its installation.

The two 140-inch electrically driven ventilating fans in the south and east wings, installed by the Buffalo Forge Co., are also adapted for experimental work.

75. **The Hydraulic Laboratory.**—This laboratory occupies a space of 40 by 60 feet on the first and second floors of the north wing adjoining the steam laboratories. A canal four feet wide, fourteen feet six inches deep, and forty feet long extends across the middle of the laboratory. Water enters this canal from the naval tank and is returned to the tank by a centrifugal pump in a well at the far end of the canal. This canal is provided with bulkheads, screens, and weirs, and is arranged for testing the flow of water over weirs and through nozzles up to a capacity of ten cubic feet per second. The bulkhead between the naval tank and the canal is arranged for weirs and nozzles so that tests may be made for flow from a still water basin as well as in a running stream. The naval tank itself is arranged for bulkheads dividing it into three basins, each one hundred feet long. By means of a sluice in the bottom of the tank these basins can be connected to the hydraulic canal and *the centrifugal* pump, so that water can be pumped from

one of the basins and delivered into either of the others. The laboratory will also have two weighing tanks for calibrating purposes, each holding six hundred cubic feet. A 36-inch pressure tank, designed for 250 pounds pressure, extends through two stories. This affords means for nozzle and motor experiments under high heads. An open tank eight feet wide, sixteen feet long and five feet deep rests on a platform near the ceiling of the second floor. The centrifugal pump supplies this tank, which serves as a forebay for water wheel tests under heads up to about twenty-five feet.

76. Electrical Engineering Laboratory.—A new laboratory, exclusively for electrical engineering, occupies the basement of the south wing of the new Engineering Building. The laboratory has a total area of about 5,000 square feet. It includes two large rooms for dynamo-electric machinery, one for direct-current apparatus, 54 by 29 feet, the other for alternating-current apparatus, 54 by 27 feet. There is also one large room for telegraph and telephone engineering, 35 by 19 feet, three rooms, each about 20 feet square, for research laboratories, and smaller rooms for storage battery, calibration of instruments, photometry, photography, etc., besides the office and private laboratory of the professor in charge.

In the dynamo room are two 10-light arc machines, two constant potential machines, and a 33 K. W. composite wound alternator made for the University by the Fort Wayne Electrical Corporation, and an 8 K. W. rotating convertor. These are all run by electric motors varying from 2½ to 50 horse-power. In addition, two small alternators of 60 and 125 cycles, respectively, are used for two-phase and three-phase experimental work. Arc lamps, banks of incandescent lamps, ammeters, voltmeters, wattmeters, galvanometers, electrodynamometers, resistances, rheostats, transformers, and a large storage battery complete the equipment. The transformers include a set for conversion from two-phase to three-phase transmission and the reverse. A well equipped photometric room adjoins the dynamo room.

The laboratory for telegraphy and telephony is equipped with apparatus to illustrate commercial systems, including apparatus for duplex and quadruplex telegraphy, and various systems of telephone exchanges.

During the summer of 1904 several machines of the latest types will be added to the present dynamos. Considerable auxiliary apparatus also will be purchased. This increase in equipment, together with the enlarged laboratory space, will improve the efficiency of all the courses offered by the department.

The University lighting plant, consisting of one 200 K. W. and two 75 K. W. Thompson-Ryan generators, is available for instruction in the department. The 200 K. W. machine is directly connected to a compound engine run at a speed of 180 revolutions a minute. The two 75 K. W. machines are connected by the Arnold system to two 15 by 14 engines and run at a speed of 250 revolutions a minute.

The system is a 220-volt one throughout, with both incandescent and arc lamps (two in a series) on the same circuits. All the feeders and mains are underground, except those running from the central plant to the University Hospital, which is supplied with current from the central plant on the campus by means of heavy cables and a "booster."

The Arnold system permits of connecting either of the pair of dynamos to either engine, or of disconnecting either so that it may be tested for efficiency by purely electrical methods. A large number of motors, varying in capacity from 1 to 50 H. P., are in service and are available for testing purposes.

77. **Marine Engineering Laboratory.**—In the basement of the New Engineering Building the east wing is devoted to the experimental tank. This tank is 300 feet long, 22 feet wide, with a depth of water of 10 feet. At the south end is a model room and work shop for the purpose of making models of vessels. The models to be tested are from twelve to fourteen feet in length. The tank is spanned by a traveling truck which is driven by a motor and can be run at any desired speed. Upon this truck are mounted the dynamometers for measuring the resistance of the models of various forms at different speeds.

Experiments upon ships' forms will be conducted in a systematic manner and the results of such experiments will give the student an intelligent idea as to the capabilities of any given form.

The action of bilge keels upon the rolling of vessels, and upon the speed, will also be subject to investigation. It is proposed in the near future to install special apparatus for the investigation of the action and properties of screw propellers.

78. **Mould Loft.**—The mould loft is situated on the top floor of the north wing of the Engineering Building, occupying a floor space of 3,600 square feet. The loft is fitted with the usual equipment, such as battens, bevel boards, benches for making moulds, etc.

Students are also allowed the use of the mould loft for the construction of small vessels. For this purpose steam boxes and bending slabs are provided. § 65.

79. **Astronomical Observatory.**—The observatory is known as the Detroit Observatory, having been founded through the liberality of citizens of Detroit. Valuable additions and improvements have been made by contributions from several sources. The building consists of a main part, with a movable dome, and two wings. The meridian circle in the east wing was constructed by Pistor & Martins, of Berlin. In the main part are mounted clocks by Tiede & Howard. The west wing contains the observatory library, which connects with the residence of the Director. The refracting telescope, mounted in the dome, has an object glass thirteen inches in diameter. It was constructed by the late Henry Fitz, of New York.

A small observatory near the main building is used in the work of instruction. It contains an equatorial telescope of six inches aperture, and a transit instrument of three inches aperture, with zenith telescope attachment.

80. **Geological Laboratory.**—Opportunity for practical work in geology is provided in rooms set apart for this use in the Museum building. The rooms are furnished with microscopes, photographic instruments, cutting and polishing lathes, and other apparatus for the preparation of specimens. Special encouragement and assistance are given to students wishing to carry on original investigations.

81. **The Libraries.**—The various libraries of the University contain about 175,000 volumes, and include a number of important special collections. The portion devoted to engineering contains the standard works in this department of science, and the files of important society proceedings and professional periodicals. One thousand periodicals are received.

The catalogue of the library is the usual card catalogue of authors and subjects.

Members of the Faculties and other officers of the University may draw books from the library, subject to certain restrictions. To all other persons it is a reference library. The reading room for general use will seat 300 readers. Separate rooms are provided for advanced students where work is pursued with the necessary books at hand.

The library is open for consultation fourteen hours daily during the academic year, nine hours daily during the six weeks of the Summer Session, and six hours daily from the close of the Summer Session until the end of the summer vacation. The only exceptions to the above are Sundays and legal holidays.

In the new building provision has been made for a reading room and for a separate engineering library.

82. **The Engineering Society.**—Several organizations of students are maintained, aside from the usual literary societies, for the reading of papers and holding discussions in various scientific lines. The Engineering Society, composed of and officered by students of this department, holds meetings, at which papers of technical interest are read, and reports made upon observations and experiments. A reading room is maintained by the society, accessible to all students of the department. Several engineers of prominence have spoken before the Society in past years. An annual, called the Michigan Technic, containing papers read before the Society, abstracts of theses, contributed articles from alumni, and other matters of professional interest, is published by the students.

SUMMER SESSION

83. The Summer Session of the University of Michigan will open June 27th, 1904. Work will be given in the Department of Literature, Science, and the Arts, Engineering, Medicine and Surgery, and Law. The session will close August 5, in all departments except in the Department of Law, in which work will continue until August 19. A special Announcement can be had by addressing Mr. James H. Wade, Secretary of the University.

84. **Courses Offered.**—In the Department of Literature, Science, and the Arts, the Summer Session affords opportunity for study in languages, history, mathematics, and the sciences. In the Department of Engineering, all of the courses in shop-practice are offered, and a part only of those in drawing, surveying, civil engineering, mechanical engineering, electrical engineering, and metallurgy. Students who wish to review studies, or make up deficiencies, preparatory to presenting themselves for admission to the Department of Engineering, will find courses directly adapted to meet their wants.

85. **Courses Required.**—Engineering students are required to take certain prescribed courses during the Summer Session between their third and fourth years. See §§ 114-115-116-117-118.

86. **Tuition Fees.**—In the Department of Literature, Science, and the Arts, and of Engineering, the tuition fee is $15, regardless of the number of courses taken, except that no tuition fee will be required of students of the Department of Engineering who are taking the work prescribed by the department for the Summer Session between the third and fourth years. §§ 114-115-116-117-118.

Students entitled to exemption from payment of the Summer Session fee must procure a certificate from the Secretary of the Department of Engineering, to be presented to the Chairman of the Executive Committee of the Summer Session at the time of registration, and to the instructors in order to gain admission to their classes.

87. **Other Laboratories.**—For a full account of all the laboratories, other than those described in this Announcement, which appertain to engineering, and their various resources, as also of the University collections for the study of art, archæology, ethnology, mineralogy, paleontology, systematic zoology, etc., consult the annual Calendar, which may be had gratis on application to Mr. James H. Wade, Secretary of the University.

88. University Organizations.—An attractive series of lectures and musical entertainments is provided each year at a low price by the Students' Lecture Association. The Choral Union is an organization of students and others for the study and practice of choral music. A course of concerts and a festival of three days in May are announced under its auspices each year.

The Oratorical Association fosters an interest in oratory, and its members have been remarkably successful in recent contests.

89. Facilities for Physical Culture.—The University is provided with excellent gymnasiums. The Waterman Gymnasium for men has cost about $65,000. The main floor, which is a rectangle with truncated corners and dimensions of 150 by 90 feet, is well equipped with the various kinds of apparatus usually found in the best modern gymnasiums. A number of smaller rooms are devoted to administration, fencing, boxing, and other special purposes, while the basement is given up to baths and lockers. The main hall is lighted in the daytime by means of a large skylight 60 feet above the floor, and in the evening by electricity. A gallery makes room for an elliptical running-track 375 feet in length.

In the conduct of the gymnasium the aim is not so much the development of a few gymnastic experts as the provision of wholesome physical exercise for the many. The facilities of the building, including physical examinations and instruction, are free to all students, the only charge being a rental of $2 a year for a locker. *Attendance twice a week is required of all first year students of this department.*

The Ferry Athletic Field of thirty acres has been set apart and equipped for open-air sports. Room is also provided for tennis courts. Much interest is manifested in foot-ball and base-ball by class and University teams.

The Ann Arbor Golf and Outing Club extends playing rights to a limited number of students. This is a private club, comprising in its membership both citizens and members of the University Faculties.

COURSES OF INSTRUCTION

90. The Courses of Instruction are subject to change from time to time; those proposed for the year 1904-5 and required for graduation, as stated in §§ 120-126, are described below, together with some advanced elective and technical courses, which are designated accordingly. The amount of credit towards graduation assigned to each course is indicated by the expressions *one hour, two hours,*

etc., an *hour of credit* being given for the satisfactory completion of work equivalent to one exercise a week during one semester. Lectures and recitations are usually one hour in length, but in laboratory work, drawing, and other practical exercises, a longer attendance is required in order to secure an hour of credit. An hour of credit represents ordinarily about three hours of actual work, including preparation.

Courses given in the Department of Literature, Science, and the Arts are (with the exception of the courses in French and in German, for which special permission is required), all open as electives to engineering students who can spare the time and are qualified to pursue them with advantage.

No credit is given for work done outside of the University during the student's connection with the Department of Engineering, unless such work is substantially equivalent to some course offered in the Department and has been done under approved supervision.

Students will be classified and assigned to sections by a Committee of the Faculty. In many subjects the size of the class requires its division into several sections.

A student enrolled in the Department of Literature, Science, and the Arts, and desiring to elect any work in this Department, must obtain written permission from the Dean of the former Department, have it approved by the Dean of the Department of Engineering, and attach the paper to the election slip.

RULES AND REGULATIONS

91. The work of students must be arranged in conformity with the following regulations:—

a. Before entering on any study the student must give the instructor satisfactory evidence that he is prepared to pursue it with advantage.

b. No student will be allowed to elect merely a part of a course, without special permission of the Faculty.

c. No credit will be allowed to a student for work in any course, unless the election of the work is formally entered on his classification blank before the work is begun.

d. After the first Saturday of each semester no study can be taken up or dropped without special permission of the Faculty.

e. All requests to the Faculty must be made out on printed forms furnished by the Secretary of the Department.

f. The Faculty requires a student to drop a part of his work at any time, if in its opinion he is undertaking too much; or to take additional work, if it thinks he is not sufficiently employed.

g. The Faculty reserves the right to withdraw the offer of any elective study not chosen by at least six persons.

h. In cases of exceptional proficiency, permission to take hours in addition to those named in the published schedule is granted by the Faculty on special request; but in all cases requests for permission to take an additional number of hours must be in the hands of the Secretary (See *e.*) on or before the ***first Saturday*** of the semester during which the additional work is desired. No permission to take extra hours will be granted to students in their first semester of residence.

i. After matriculation, a student cannot, without special permission of the Faculty, be admitted to examination in any one of the courses given, until he has received in the University the regular instruction in such course.

REMOVAL OF CONDITIONS

92. An applicant who fails in some part of the entrance examination may, at the discretion of the Faculty, be admitted conditionally; but any condition so imposed must be removed at one of the next two regular examinations for admission, and no student who has an admission condition outstanding at the beginning of his second year of residence, will be allowed to enter his classes until such condition is removed.

Examinations for the removal of conditions incurred in regular work will be held three times during the year, viz., on the last Friday and Saturday of the Summer Vacation, the first Friday and Saturday after the Christmas Vacation, and the first Friday and Saturday after the Spring Recess.

Students who wish to present themselves for examination in any subject for the removal of a condition must present to the *instructor in charge* as early as Wednesday before the examination, a supplementary examination slip obtained from the Secretary.

Any student reported as *passed conditionally* in any course must remove such condition at one or the other of the first two regular examinations for the removal of conditions immediately following the semester in which such condition was incurred; otherwise the course passed conditionally will be regarded as *not passed.*

The time limit for the removal of an incomplete is the same as for a condition. If not removed within this time it becomes a condition and follows the rule governing conditions.

The courses announced for the year 1904-5 are as follows:

93. ENGLISH

Mr. ABBOTT and Mr. TARBOX.

FIRST SEMESTER

*1. Paragraphing and Theme Writing. *Four hours.*
2. Technical Journalism. *Two hours.*

SECOND SEMESTER

1. Paragraphing and Theme Writing. *Four hours.*
3. Advanced Composition. *Two hours.*

Consultation hours to be arranged with the instructor.

For a description of the courses in English see § 25.

94. FRENCH†

Mr. BIRD and Mr. ———.

FIRST SEMESTER

1. Elementary Course. Grammar and Reading, with constant practice in writing and speaking French. *Four hours.*

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*All course numbers not followed by *letters in brackets* indicate subjects offered in the Department of Engineering only. The symbol [*a*] following a course number indicates that the course thus designated is also offered in the Department of Literature, Science, and the Arts.

†See note bottom of following page.

2. Elementary Course continued. Grammar and Reading, with constant practice in writing and speaking French. *Four hours.*
3. Reading of French Scientific Literature. *Four hours.*
4. Reading of French Scientific Literature continued. *Four hours.*
   In Courses 3 and 4 students of special aptitude and proficiency will be given opportunity and encouraged to do extra work.
5. Advanced Course in Reading of French Scientific Literature. *Three hours.* (Elective.)
6. French Conversation. *Three hours.* (Elective.)
7. Commercial and Journalistic Newspaper French. *Three hours.* (Elective.)
8. A Course in Literary French. *Three hours.* (Elective.)
   An *Elective Course* will not be given unless applied for by six or more students qualified to take it.

SECOND SEMESTER

1. Elementary Course. Grammar and Reading, with constant practice in writing and speaking French. *Four hours.*
2. Elementary Course continued. Grammar and Reading, with constant practice in writing and speaking French. *Four hours.*
3. Reading of French Scientific Literature. *Four. hours.*
4. Reading of French Scientific Literature continued. *Four hours.*
   In Courses 3 and 4 students of special aptitude and proficiency will be given opportunity and encouraged to do extra work.
5. Advanced Course in Reading of French Scientific Literature. *Three hours.* (Elective.)
6. French Conversation. *Three hours.* (Elective.)
7. Commercial and Journalistic Newspaper French. *Three hours.* (Elective.)
8. A Course in Literary French. *Three hours.* (Elective.)
   An *Elective Course* will not be given unless applied for by six or more students qualified to take it.

95. GERMAN *

Assistant Professor WAIT, Mr. DUBEE, Mr. MENGER.

FIRST SEMESTER

1. Elementary Course. Grammar and Reading, with constant practice in writing and speaking German. *Four hours.*
2. Elementary Course continued. Grammar and Reading, with constant practice in writing and speaking German. *Four hours.*

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*A student admitted on German will take Eight Hours of German and either Eight Hours of French or Eight Hours of Spanish.

A student admitted on French will take Twelve Hours of German and Four Hours of French, or he will take Eight Hours of French and Eight Hours of Spanish.

A student admitted on Latin will take *one* of the three options, viz.,
(a) Sixteen Hours of German.
(b) Sixteen Hours of French.
(c) Eight Hours of French and Eight Hours of Spanish.

3. Reading of German Scientific Literature. *Four hours.*
4. Reading of German Scientific Literature continued. *Four hours.* In Courses 3 and 4 students of special aptitude and proficiency will be given opportunity and encouraged to do extra work.
5. Advanced Course in Reading of German Scientific Literature. *Three hours.* (Elective.)
6. German Conversation. *Three hours.* (Elective.)
7. Commercial and Journalistic Newspaper German. *Three hours.* (Elective.)
8. A Course in Literary German. *Three hours.* (Elective.)

An *Elective Course* will not be given unless applied for by six or more students qualified to take it.

SECOND SEMESTER

1. Elementary Course. Grammar and Reading, with constant practice in writing and speaking German. *Four hours.*
2. Elementary Course continued. Grammar and Reading, with constant practice in writing and speaking German. *Four hours.*
3. Reading of German Scientific Literature. *Four hours.*
4. Reading of German Scientific Literature continued. *Four hours.* In Courses 3 and 4 students of special aptitude and proficiency will be given opportunity and encouraged to do extra work.
5. Advanced Course in Reading of German Scientific Literature. *Three hours.* (Elective.)
6. German Conversation. *Three hours.* (Elective.)
7. Commercial and Journalistic Newspaper German. *Three hours.* (Elective.)
8. A Course in Literary German. *Three hours.* (Elective.)

An *Elective Course* will not be given unless applied for by six or more students qualified to take it.

96. SPANISH

Mr. ———.

FIRST SEMESTER

1. Elementary Course. Grammar and Reading, with constant practice in writing and speaking Spanish. *Four hours.*
2. Elementary Course continued. Grammar and Reading, with constant practice in writing and speaking Spanish. *Four hours.*
3. Reading, Conversation, and Business Correspondence. *Four hours.*

SECOND SEMESTER

1. Elementary Course. Grammar and Reading, with constant practice in writing and speaking Spanish. *Four hours.*
2. Elementary Course continued. Grammar and Reading, with constant practice in writing and speaking Spanish. *Four hours.*
3. Reading, Conversation, and Business Correspondence. *Four hours.*

97. MATHEMATICS

Professor Ziwet, Professor Markley, Assistant Professor Glover,
Mr. Butts, Mr. Escott, Mr. Marshall, Dr. Running,
Dr. Pierce, Dr. Field, Mr. Bradshaw, Mr. ———.

Students of engineering are required to take in order Courses 1, 2, 3, 4, 5, and 6. § 27. Those admitted with a deficiency in plane trigonometry may remove it by completing Course 1*a*, but the credit thus obtained is entered on the admission, not the graduation requirements. § 113.

FIRST SEMESTER

1. [*a*] Algebra and Analytic Geometry (I). *Four hours.*
1*a*. [*a*] Plane Trigonometry. *Two hours.*
3. [*a*] Calculus. *Five hours.*
5. [*a*] Calculus and Mechanics (II). *Three hours.*

SECOND SEMESTER

2. [*a*] Analytic Geometry (II). *Four hours.*
4. [*a*] Calculus and Mechanics (I). *Five hours.*
6. [*a*] Calculus and Mechanics (III). *Two hours.*

Other and advanced courses are given in the Department of Literature, Science, and the Arts.

98. PHYSICS

Professor Carhart, Professor Patterson, Professor Reed, Dr. Randall, Dr. Smith, Mr. Morehouse, Mr. Henderson.

FIRST SEMESTER

2. [*a*] Heat, Electricity, and Magnetism. Lectures and recitations. *Five hours.*

Course 2 must be preceded by Course 1 and by Course 2 in chemistry.

3*b*. [*a*] Physical Laboratory Work for Beginners. *Two hours.* Fee, $2.

Course 3*b* must be preceded or accompanied by Course 1.

3*c*. [*a*] Laboratory Work in Mechanical and Electrical Measurements. *Three hours.* Fee, $3.

Course 3*c* must be preceded by Course 2. It is designed for students who wish to prepare for the study of dynamo-electric machinery.

Note.—After the year 1904-5 a change will be made in this course.

7. Mathematical Electricity and Magnetism. *Three hours.* (Elective.)

Course 7 must be preceded by Course 2. A knowledge of calculus is required.

8. [*a*] Heat. Laboratory work. *Two hours.* (Elective.)
Course 8 must be preceded by Course 2. Fee, $2.

9. [*a*] Theory of Heat. *Two hours.* (Elective.)

SECOND SEMESTER

1. Mechanics, Sound, and Light. Lectures and recitations. *Five hours.*
For Course 1 a knowledge of plane trigonometry is indispensable.

3*b*. [*a*] Physical Laboratory Work for Beginners. *Two hours.* Fee, $2.
Course 3*b* must be preceded or accompanied by Course 1.

3*c*. [*a*] Laboratory Work in Mechanical and Electrical Measurements. *Three hours.* Fee, $3.
Course 3*c* must be preceded by Course 2. It is designed for students who wish to prepare for the study of dynamo-electric machinery.

10. Mathematical Electricity and Magnetism. *Two hours.* (Elective.)
Course 10 must be preceded by Course 7.

16. Theories of Solutions, Electrolytes, and the Voltaic Cell. Lectures and laboratory work. *Three hours.* (Elective.)
Course 16 must be preceded by Course 2 in electrical engineering and by Course 2 in Chemistry. It is also desirable for the student to have had laboratory work in chemistry. Fee, $1.

99. CHEMISTRY

Professor Prescott, Professor Johnson, Professor Campbell, Professor Gomberg, Assistant Professor White, Mr. Higley, Mr. Smeaton, Mr. Willard.

Students admitted with a deficiency in entrance chemistry may remove it by completing Course 1, but the credit thus obtained is entered on the admission, not the graduation requirements. § 113.

Other courses in chemistry are given in the Department of Literature, Science, and the Arts.

FIRST SEMESTER

1. [*a*] Elementary Inorganic Chemistry. Experimental lectures and recitations. *Two hours.* (For entrance see above.)

2. Principles of Inorganic Chemistry. Lectures and recitations. *Four hours.*
Open to those who have passed the entrance requirements in chemistry. (Old Course A)

3. [*a*] Qualitative Analysis. Recitations and laboratory work. *Seven hours.*
Open to those who have completed Course 2 or an equivalent.

5. [*a*] Quantitative Analysis. Beginning course. Recitations and laboratory work. *Five hours.*
Open to those who have completed Course 3.

7. [*a*] Organic Chemistry. Lectures and library studies. *Five hours.*
Open to those who have completed Course 3.

28. [*a*] Advanced Quantitative Analysis. Laboratory work. *Five hours.*
Open to those who have completed Course 5.

29. [*a*] Iron and Steel Analysis. *Five hours.* Laboratory work, *daily.*
Open to those who have taken Course 28 and who receive special permission.

31. [*a*] Independent Work in Mineral Analysis. Laboratory work. *Five hours.*
Open to those who have completed Course 28.

32. [*a*] Technical Examination of Gold and Silver Ores, including the Fire Assay. Laboratory work with lectures and reading. *Two hours.*
Open to those who have completed Course 28. Course 2 in Mineralogy is recommended.

33. [*a*] Chemical Technology. A study of chemical manipulations and reactions on a manufacturing scale. Fuels, water, the acid and alkali industries, clay products, cements, and glass. Lectures, recitations, and assigned reading. *Five hours.*
Open to those who have completed Course 3.

35. [*a*] Technical Gas Analysis, including Calorimetry and Photometry. Laboratory work. *Two hours.*
Open to those who have completed Course 5.

39. [*a*] Chemical Technology. Laboratory work. Courses are regularly offered in:—1. The manufacture of hydraulic cement, with special reference to relation of composition and temperature of burning to physical properties. 2. Coal, gas, and its by-products. 3. Influence of heat and mechanical treatment on constitution of iron and steel. 4. The chemistry of beet sugar, with special reference to its manufacture. Other subjects may be chosen on consultation. *Hours and credit to be arranged with the instructor.*
Course 39 must be preceded by Courses 28 and 33, with Courses 7 and 38 in addition, if the subject chosen is in organic technology.

42. [*a*] Organic Synthesis. Laboratory work. *Three, four, or five hours.*
Course 42 must be preceded by Course 5 and be preceded or accompanied by Course 7.

PRIMARILY FOR GRADUATES

a] Original Investigation in Quantitative Analysis. Laboratory work. *Credit arranged with instructor.*

SECOND SEMESTER

Principles of Inorganic Chemistry. Lectures and recitations. *Four hours.*

Open to those who have passed the entrance requirements in chemistry. (Old Course A)

a] Qualitative Analysis. Recitations and laboratory work. *Seven hours.*

Open to those who have completed Course 2 or an equivalent.

a] Quantitative Analysis. Beginning course. Recitations and laboratory work. *Five hours.*

Open to those who have completed Course 3.

a] Advanced Quantitative Analysis. Laboratory work. *Five hours.*

Open to those who have completed Course 5.

a] Iron and Steel Analysis. *Five hours.* Laboratory work, *daily.*

Open to those who have taken Course 28 and who receive special permission.

a] Independent Work in Mineral Analysis. Laboratory work. *Five hours.*

Open to those who have completed Course 28.

a] Technical Gas Analysis, including Calorimetry and Photometry. Laboratory work. *Two hours.*

Open to those who have completed Course 5.

a] Organic Technology. The industrial chemistry of organic compounds. Destructive distillation of coal and wood with recovery of by-products; illuminating gas; starch, glucose and sugar; fermentation and distillation; fats, oils and soaps; bleaching and dyeing; tanning; paper manufacture. Lectures, recitations, and assigned reading. *Five hours.*

Open to those who have completed Courses 7 and 33.

a] Chemical Technology. Laboratory work. Courses are regularly offered in:—1. The manufacture of hydraulic cement, with special reference to relation of composition and temperature of burning to physical properties. 2. Coal, gas, and its by-products. 3. Influence of heat and mechanical treatment on constitution of iron and steel. 4. The chemistry of beet sugar, with special reference to its manufacture. Other subjects may be chosen on consultation. *Hours and credit to be arranged with the instructor.*

Course 39 must be preceded by Courses 28 and 33, with Courses 7 and 38 in addition, if the subject chosen is in organic technology.

42. [a] Organic Synthesis. Laboratory work. *Three, four, or five hours.*

Course 42 must be preceded by Course 5 and be preceded or accompanied by Course 7.

PRIMARILY FOR GRADUATES

37. [a] Original Investigation in Quantitative Analysis. Laboratory work. *Credit arranged with instructor.*

100. METALLURGY

Professor Campbell, Assistant Professor White, Mr. Smeaton.

FIRST SEMESTER

1. [a] Fuel and Refractory Material, Iron and Steel. *Three hours.* Course 1 must be preceded by Course 2 in chemistry.

2. [a] Descriptive study of the influence of mechanical and heat treatment upon the microstructure and properties of metals and alloys. Lectures and reading. *One hour.* Open only to those who have taken Course 1.

3. [a] Micrometallography. Laboratory course on the microscopic structure of metals and alloys as related to their physical and chemical properties. *One hour.* Must be preceded or accompanied by Course 2.

SECOND SEMESTER

2. [a] Descriptive study of the influence of mechanical and heat treatment upon the microstructure and properties of metals and alloys. Lectures and reading. *One hour.* Open only to those who have taken Course 1.

3. [a] Micrometallography. Laboratory course on the microscopic structure of metals and alloys as related to their physical and chemical properties. *One hour.* Must be preceded or accompanied by Course 2.

SUMMER SESSION

1. [a] Fuel and Refractory Material, Iron and Steel. *Three hours.* Course 1 must be preceded by Course 2 in Chemistry.

101. ASTRONOMY

Professor Hall and Mr. March.

FIRST SEMESTER

4. [a] Practical Astronomy. Use of sextant and transit. *Three hours.* Course 4 requires a knowledge of spherical trigonometry and of differential and integral calculus.

5. [*a*] Spherical Astronomy. *Three hours.*
In Course 5 some standard work on spherical astronomy is rapidly read, and special subjects are given out for discussion. Courses 5 and 9 follow Course 4 and are intended for students interested in geodetic work.

13. [*a*] Theory of Least Squares. *Two hours.*

SECOND SEMESTER

4. [*a*] Practical Astronomy. Use of sextant and transit. *Three hours.* Course 4 requires a knowledge of spherical trigonometry and of differential and integral calculus.

9. Practical Astronomy: extended course. *Hours of credit to be arranged.*

102.

MINERALOGY

Professor ———.

FIRST SEMESTER

1. [*a*] Lectures and practice. *Two hours.*
For Course 1 an elementary knowledge of chemistry is desirable.

SECOND SEMESTER

1. [*a*] Lectures and practice. *Two hours.*
For Course 1 an elementary knowledge of chemistry is desirable.

103.

GEOLOGY

Professor RUSSELL.

SECOND SEMESTER

6. [*a*] Elements of Geology. Text-book and lectures. *Three hours.*

104.

DRAWING

Professor DENISON, Assistant Professor WRENTMORE, Assistant Professor GOULDING, Miss HUNT, Mr. WILSON, Mr. BARTLETT, Mr. PAGE.

FIRST SEMESTER

1. [*a*] Geometrical Drawing. *Four hours.* § 30.

4. [*a*] Free-Hand Drawing. Pencil, Pen and Ink. Sketching. *Three hours.*

10. [*a*] Continuation of Course 8. *Two hours.* (Elective.)
Course 10 must be preceded by Courses 4, 7, and 8.

13. [*a*] Water-Color Drawing. *Three hours.* (Elective.)
Course 13 must be preceded by Course 8. It can be taken only by special permission.

SECOND SEMESTER

4. [*a*] Free-Hand Drawing. Pencil, Pen and Ink. Sketching. *Three hours.*
5. [*a*] Descriptive Geometry. Recitations and Drawing. *Four hours.*
   Course 5 must be preceded by Course 1.
6. [*a*] Shades, Shadows, and Perspective. *Three hours.* (Elective.)
   Course 6 must be preceded by Course 5.
7. [*a*] Free-Hand Drawing (advanced). *Three hours.* (Elective.)
8. [*a*] Architectural and Water-Color Drawing. *Two hours.* (Elective.)
   Course 8 must be preceded by Course 1 or 4.
14. [*a*] Stereotomy. *Two hours.*
   Course 14 must be preceded by Course 5.
16. [*a*] Free-Hand Lettering. *Two hours.* (Elective.)
   Course 16 must be preceded by Course 1.
17. [*a*] Spherical Projections. *One hour.* (Elective.)
   Course 17 must be preceded by Course 5.

105. SHOP PRACTICE

Superintendent Miggett; Shop-Instructors Purfield, Winslow, Cobb, McDonald, Willard.

Reading is assigned by the Superintendent upon general workshop construction, equipment, and management. Courses 1 to 4 may be continued by advanced students as Courses 1*a* to 4*a*.

Special arrangements are made for students who desire to take more advanced work in the shop courses with a view to preparing themselves for teaching these subjects. § 31.

FIRST SEMESTER

1. Carpentry and Blacksmithing. *Four hours.* Fee, $10.
   (Old 1*a* and 2*a* combined.)
1*b*. Pattern Making. *Two hours.* Fee, $5.
3*a*. Foundry Work. *Two hours.* Fee, $5.
3. Machine Shop. *Four hours.* Fee, $10.
   (Old 4*a* and 4*b* combined.)

SECOND SEMESTER

1. Carpentry and Blacksmithing. *Four hours.* Fee, $10.
   (Old 1*a* and 2*a* combined.)
1*b*. Pattern Making. *Two hours.* Fee, $5.
3*a*. Foundry Work. *Two hours.* Fee, $5.
3. Machine Shop. *Four hours.* Fee, $10.
   (Old 4*a* and 4*b* combined.)
4. Instrument Work. *Two hours.* Fee, $5.
   Course 4 must be preceded by shop practice Course 1, and physics Course 3*b*.

SUMMER SESSION

1. Carpentry and Blacksmithing. *Four hours.* Fee, $10.
   (Old 1*a* and 2*a* combined.)

1*b*. Pattern Making. *Two hours.* Fee, $5.

3*a*. Foundry Work. *Two hours.* Fee, $5.

3. Machine Shop. *Four hours.* Fee, $10.
   (Old 4*a* and 4*b* combined.)

4. Instrument Work. *Two hours.* Fee, $5.
   Course 4 must be preceded by shop practice Course 1, and physics Course 3*b*.

106. SURVEYING

Professor J. B. DAVIS, Mr. MERRICK.

FIRST SEMESTER

1. Surveying. Lectures, Text-book, and Field Practice. *Five hours.* § 33.
   The field practice in Course 1 continues during favorable weather until Christmas.

4. Use of instruments. *One hour.* § 33 (*b*).

SECOND SEMESTER

2. Continuation of Course 1. Lectures and text-book. *Five hours.*
   Course 2 must be preceded by Course 1.

5. Topography. Transit and Stadia. Plane Table. Camera. Field Work and Drawing. *Four hours.*

7. Geodesy. Geodetic Methods. Lectures and texts. *Three hours.* (Elective.) § 34.
   Course 7 must be preceded by Courses 1 and 2.

SUMMER SESSION

3. Field Work in Camp. *Six weeks.* § 33.
   Open only to students in civil engineering except by special permission of the Faculty.

107. CIVIL ENGINEERING

Professor WILLIAMS, Professor J. B. DAVIS, Assistant Professor WRENTMORE, Assistant Professor GREENE, Mr. WILSON, Mr. ———.

FIRST SEMESTER

1. Municipal Engineering. Lectures and texts. *Five hours.* (Elective.) § 37.

3. Graphical Analysis of Structures. *Two hours.*

4. Graphical Analysis of Structures. *Two hours.* § 40.
   Course 4 must be preceded by Course 3.

6. Engineering. Theory of Construction. *Two hours.* § 39.
   Course 6 must be preceded by Course 4 in mathematics.
7. Engineering Design. *Five hours.* § 44.
   Course 7 accompanies Course 6.
9. Hydraulics. *One hour.*
   Course 9 must be preceded by Course 5 in mathematics.
15. Highway Construction. *Two hours.*

PRIMARILY FOR GRADUATES

11. Engineering Design (advanced). *Five hours.*
12. Water Supply and Sewerage. *Two hours.*

SECOND SEMESTER

2. Tests of Materials. *One hour.* (Elective.)
3. Graphical Analysis of Structures. *Two hours.*
   Course 3 must be preceded by Course 4 in mathematics.
   For the electrical engineering students and for this year only.
5. Strength and Resistance of Materials. *Three hours.* § 38.
   Course 5 must be preceded by Course 4 in mathematics.
8. Engineering. Theory of Construction. *Three hours.*
   Course 8 must be preceded by Courses 3 and 6.
10. Water Supply and Sewerage. *One hour.* (Elective.)
    Course 10 follows Course 9.
17. The Design, Construction and Management of Water Works with particular consideration of the Sanitary side of the Subject. Lectures and text-book work. *Four hours.* Open to seniors and graduate students.
    Course 17 deals with the relations of water supply to public health, and the water borne diseases, from the Engineers' standpoint; the selection of sources of water supplies, and the purification of water; the design of works for the collection, delivery, distribution and purification of water, and the management, operation, and valuation of such works.

PRIMARILY FOR GRADUATES

13. Economics of Railway Location. *One hour.*
14. Contracts and Specifications. *One hour.*
16. Hydraulics. Laboratory work.
    This course will be offered on completion of the hydraulic laboratory. § 49.

108. MECHANICAL ENGINEERING

Professor Cooley, Professor Denison, Professor Allen, Assistant Professor Wrentmore, Superintendent Miggett, Assistant Professor Anderson, Assistant Professor Goulding, Assistant Professor Hazelton, Mr. Bursley, Mr. Bragg, Mr. ———, Mr. ———.

FIRST SEMESTER

2. Elements of Mechanism. *Three hours.* § 42.
   Course 2, for civil engineering students, is *two hours.*
   Course 2 must be preceded by Course 1 in mathematics, and by Courses 1 and 5 in drawing.
4. Boilers. Steam Engines. *Two hours.*
   Course 4 must be preceded by Course 1 in physics, and preceded or accompanied by Course 4 in mathematics.
6. Machine Design. Machine Tools. *Two hours.* § 43.
   Course 6 must be preceded or accompanied by Course 2, and be preceded by Courses 1, 4, 5, in drawing.
7. Hydraulic Machinery. One hour lecture, one hour quiz twice a week. *Two hours.*
   Course 7 must be preceded by Course 4 in mathematics, and by Course 1 in physics.
8. Theory of Machine Design. *Three hours.*
   Course 8 must be preceded by Course 5 in civil engineering.
10. Machine Design. Hoisting Machinery. *Three hours.* § 44.
    Course 10 must be preceded or accompanied by Course 8, and preceded by Course 6.
11. Laboratory Work. Steam Engineering. *Three hours.* Fee, $5.
    Course 11 must be preceded or accompanied by Courses 4, 7, 9.
12. Machine Design. Boilers and Engines. *Two hours.*
    Course 12 must be preceded by Courses 4, 5, 6 in mechanical engineering, and Course 5 in civil engineering.
19. Gas Engines. *Two hours.*
    Course 19 must be preceded by Course 13.

PRIMARILY FOR GRADUATES

16. Heating and Ventilation. *Two hours.* § 50.
    Course 16 must be preceded by Course 4.
18. Hydraulic Machinery (advanced). *Two hours.*
    Course 18 must be preceded by Course 7.
20. Laboratory Work. Advanced Course. *Two hours.*
    Course 20 must be preceded by Courses 9, 11.

SECOND SEMESTER

1. Elements of Machines. Nomenclature. *Two hours.*
4. Boilers. Steam Engines. *Two hours.*
   Course 4 must be preceded by Course 1 in physics, and preceded or accompanied by Course 4 in mathematics.

5. Valve Gears. Graphical Statics of Mechanism. *Two hours.*
Course 5 must be preceded by Course 2.

6. Machine Design. Machine Tools. *Two hours.* § 43.
Course 6 must be preceded or accompanied by Course 2, and be preceded by Courses 1, 4, 5, in drawing.

9. Laboratory Work. Power Measurements. Machine Testing. *Two hours.* Fee, $5.
Course 9 must be preceded by Course 4.

10. Machine Design. Hoisting Machinery. *Three hours.* § 44.
Course 10 must be preceded or accompanied by Course 8, and preceded by Course 6.

11. Laboratory Work. Steam Engineering. *Three hours.* Fee, $5.
Course 11 must be preceded or accompanied by Courses 4, 7, 9.

12. Machine Design. Boilers and Engines. *Two hours.*
Course 12 must be preceded by Courses 4, 5, 6 in mechanical engineering, and Course 5 in civil engineering.

13. Thermodynamics. Steam and Other Heat Engines. *Three hours.* § 47.
Course 13 must be preceded by Course 4.

14. Power Plants. Power Transmission. *Two hours.*
Course 14 must be preceded by Courses 4, 7.

17. Compressed Air. Mechanical Refrigeration. *Two hours.* § 49.
Course 17 must be preceded by Course 13.

PRIMARILY FOR GRADUATES

21. Specifications and Contracts. *One hour.*
Course 21 must be preceded or accompanied by Course 14.

22. Thermodynamics (advanced). *Two hours.*
Course 22 must be preceded by Course 13.

23. Machine Design (advanced). *Three hours.*
Course 23 must be preceded by Courses 10 and 12.

24. Hydraulic Machinery. Laboratory work.
This course will be offered on completion of the hydraulic laboratory. § 51.

109. ELECTRICAL ENGINEERING

Professor Patterson, Mr. Bailey, Dr. A. W. Smith,
Mr. Morehouse.

FIRST SEMESTER

2. Electrical Measurements. Recitations and laboratory work. *Four hours.* Fee, $3. § 52.
Course 2 must be preceded by Courses 1, 2, 3 in physics; a knowledge of calculus is required.

5. Alternate Current Apparatus. Recitations and laboratory work. *Four hours.* Fee, $1. § 53.
Course 5 must be preceded by Course 4.

6. Photometry of Electric Lamps. Recitations and laboratory work. *One hour.* Fee, $1.
7. Design of Electrical Machinery and Appliances. *Four hours.* Course 7 must be preceded by Course 4.

SECOND SEMESTER

1. Primary and Storage Batteries. Recitations and laboratory work. *Two hours.* Fee, $1. § 51.
   Course 1 must be preceded by Courses 1, 2, 3 in physics, and Course 2 in chemistry.
3. Electrical Measurements. Continuation of Course 2. Lectures and laboratory work. *Three hours.* Fee, $2.

4*a*. Dynamo-electric Machinery. Lectures, recitations, and laboratory work. *Four hours.* Fee, $2. § 53.
Course 4*a* must be preceded by Course 2.

4*b*. Dynamo-electric Machinery, as in Course 4*a*. *Three hours.* Fee, $1.
Course 4*b* must be preceded by Course 3*c* in physics or Course 2 in electrical engineering.

8. Distribution of Electricity. Lectures, recitations, and laboratory work. *Three hours.* Fee, $1. § 55.
   Course 8 must be preceded by Course 4.
10. Advanced Course in Design of Electrical Apparatus. Drawing. *Two hours.*
11. Telephone and Telegraph. *Two hours.*
    Course 11 must be preceded by Course 4.
12. Telephone and Telegraph. Laboratory work. *Two hours.*
    Course 12 must be preceded or accompanied by Course 11.

PRIMARILY FOR GRADUATES

9. Alternating Current Phenomena. *Two hours.*
   Course 9 must be preceded by Course 5.

SUMMER SESSION

4*b*. Dynamo-electric Machinery, as in second semester. *Three hours.* For mechanical and chemical engineering students.

110. CHEMICAL ENGINEERING (See *Chemistry*, § 99.)

111. NAVAL ARCHITECTURE AND MARINE ENGINEERING

Professor Cooley, Professor Sadler, Mr. Bragg.

Note.—The old numbering of the following courses is given in parentheses.

FIRST SEMESTER

1. (1*a*). Naval Architecture. Structural Design. Lectures and recitations. *One hour.*
2. (1). Naval Architecture. Ship calculations. Lectures and recitations. *Two hours.*

3. (1). Naval Architecture. Strength of ships and preliminary design. *Two hours.*

Course 3 must be preceded or accompanied by Course 2.

5. (4*a*). Naval Architecture. Mould loft and structural drawing. *Two hours.*

6. (3) Naval Architecture. Ship drawing and design. *Three hours.*

8. (2). Marine Engines and Boilers. Lectures and recitations. *Two hours.*

10. (4). Marine Engine and Boiler Drawing and Design. *One hour.*

SECOND SEMESTER

1. (1*a*). Naval Architecture. Structural design. Lectures and recitations. *One hour.*

2. (1). Naval Architecture. Ship calculations. Lectures and recitations. *Two hours.*

4. (5). Naval Architecture. Stability, resistance and propulsion of ships. *Four hours.*

5. (4*a*). Naval Architecture. Mould loft and structural drawing. *Two hours.*

7. (7). Naval Architecture. Ship drawing and design. *Three hours.*

9. (6). Marine Engines and Boilers. Lectures and recitations. *Three hours.*

11. (8). Marine Engine and Boiler Drawing and Design.

PRIMARILY FOR GRADUATES

12. Experimental Tank Work. *Two hours.*

13. (9). Ship and Engine Specifications. *Two hours.*

14. (10). Pumping and Ventilation. *One hour.*

15. (11). Advanced Reading. *Three hours.*

16. (12). Advanced Drawing. *Five hours.*

Courses 1 to 8 should be taken in the fourth year by students who expect to graduate in Marine Engineering.

Students wishing to specialize in Marine Engine and Boiler Design will elect Courses 6 and 7 as *three hours* each, and Courses 10 and 11 as *one hour* each.

SEQUENCE OF STUDIES

112. The work of the first two years is the same for all regular students. At the end of the second year, the student makes his choice to continue in the civil engineering, the mechanical engineering, the electrical engineering, the chemical engineering, or the marine engineering course. The student, in any course but chemical engi-

neering, who desires to graduate in marine engineering, will elect the work in naval architecture and marine engineering in his *fourth* year, as specified in § 119.

There is a limited opportunity for electives in some semesters, and credits obtained in advance at entrance may leave a place for substitutions. After the first year the student may take work to the amount of *eighteen hours* per week, as arranged by the classification committee; but *he may wisely, in some cases, take a smaller number of hours,* if he can in that way do more thorough work. See "Rules and Regulations," § 91.

113. NEW ORDER OF STUDIES

The order of studies for the first two years for students entering *after* commencement, 1904, and thereafter, is as follows. It is not absolutely fixed, but the student is advised to adhere to it closely to avoid conflicts, as the days and hours assigned to the several courses are arranged to correspond with this order.

The order of studies for the third and fourth years will be announced later.

One hundred and forty hours will hereafter be required for graduation, the thesis being omitted.

First Year

FIRST SEMESTER		SECOND SEMESTER	
Mathematics 1,	4 hours	Mathematics 2,	4 hours
*Language,	4 hours	*Language,	4 hours
English 1 or †*Chemistry 2,*	4 hours	Chemistry 2 or †*English* 1,	4 hours
Drawing 1 or †*Shop Work* 1 (Wood and Forge)	4 hours	Shop Work 1 (Wood and Forge) or †*Drawing* 1,	4 hours
	16 hours		16 hours

Students who have not passed plane trigonometry and chemistry for admission must omit *four hours* of the work listed for the *first semester* and substitute Mathematics 1*a* and Chemistry 1.

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*See note, page 52.

†The student taking Chemistry 2 the first semester will take English 1 the second semester; likewise, the student taking Shop Work 1 the first semester will take Drawing 1 the second semester; and *vice versa.*

Those who lack one of the above subjects must drop *four hours* to allow for its substitution.

Both of the above substitutions seriously disarrange the order of studies in later years, and frequently make it necessary for the student to attend the University an additional half year, and in some cases an additional full year, in order to complete the requirements for graduation. For this reason it is strongly advised that the deficiencies above noted be removed by completing the work in the Summer Session previous to entrance.

Summer Session Announcements may be obtained the latter part of March by writing to James H. Wade, Secretary of the University of Michigan.

Second Year

FIRST SEMESTER		SECOND SEMESTER	
Mathematics 3,	5 hours	Mathematics 4,	5 hours
Physics 1,	5 hours	Physics 2,	5 hours
*Language,	4 hours	*Language,	4 hours
Drawing 5, 4 hours or ‡*Drawing* 4, 2 hours and *Physics 3b,* 2 hours	4 hours	Drawing 4, 2 hcurs and Physics *3b,* 2 hours or ‡*Drawing* 5, 4 hours	4 hours
	18 hours		18 hours

114.

OLD ORDER OF STUDIES

The order of studies for the second, third and fourth years for students who entered *prior* to commencement 1904 is as follows. It is not absolutely fixed, but the student is advised to adhere to it closely to avoid conflicts, as the days and hours assigned to the several courses are arranged to correspond to this order.

Students working under the old order of studies are permitted a choice of preparing a thesis for graduation, or, of taking an amount of work elected from among the courses offered in the Department of Engineering but not required, the equivalent of a thesis, as may be determined by the head of the department in which the student seeks his degree.

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*See note, page 52.

‡Note similar to † on preceding page.

CIVIL

Second Year

FIRST SEMESTER		SECOND SEMESTER	
French or German 1,	4 hours	French or German 2,	4 hours
Mathematics 3,	5 hours	English 1*a*,	2 hours
Physics 2,	5 hours	Mathematics 4,	5 hours
Drawing 4,	3 hours	Physics 3*c*,	3 hours
Mineralogy 1,	2 hours	Drawing 14,	2 hours
		Geology 1,	3 hours
	19 hours		19 hours

Third Year

FIRST SEMESTER		SECOND SEMESTER	
French or German 3,	4 hours	Mathematics 6,	2 hours
Mathematics 5,	3 hours	Surveying 2,	5 hours
Surveying 1,	5 hours	Surveying 5,	4 hours
Civil Engineering 3,	2 hours	Civil Engineering 5,	3 hours
Mech. Engineering 2,	2 hours	Elect. Engineering 4*b*,	3 hours
Mech. Engineering 4,	2 hours		
			17 hours
	18 hours		

Summer Session

Surveying 3,	6 hours

Fourth Year

FIRST SEMESTER		SECOND SEMESTER	
Astronomy 4,*	3 hours	Astronomy 4,*	3 hours
Civil Engineering 4,	2 hours	Civil Engineering 8,	3 hours
Civil Engineering 6,	2 hours		
Civil Engineering 7,	5 hours		3 or 6 hours
Civil Engineering 9,	1 hour	Electives	
Civil Engineering 15,	2 hours	Thesis	
Mech. Engineering 7,	2 hours		
	14 or 17 hours		

Total hours prescribed, 129. Required for graduation, 130 and a thesis.

After completing his third year of the above course a student may, if he desire, change to the course in Marine Engineering by taking the subjects indicated in § 119 during his fourth year.

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*One-half of the class each semester.

115. MECHANICAL

Second Year

FIRST SEMESTER		SECOND SEMESTER	
French or German 1,	4 hours	French or German 2,	4 hours
Mathematics 3,	5 hours	English 1a,	2 hours
Physics 2,	5 hours	Mathematics 4,	5 hours
Shop Work *1b*,	2 hours	Drawing 4,	3 hours
Mech. Engineering 1,	2 hours	Shop Work *4a*,	3 hours
	—	Mech. Engineering 4,	2 hours
	18 hours		—
			19 hours

Third Year

FIRST SEMESTER		SECOND SEMESTER	
French or German 3,	4 hours	Mathematics 6,	2 hours
Mathematics 5,	3 hours	Shop Work *3a*,	2 hours
Physics *3c*,	3 hours	Civil Engineering 5,	3 hours
Shop Work *4b*,	2 hours	Mech. Engineering 5,	2 hours
Surveying 4,	1 hour	Mech. Engineering 6,	2 hours
Civil Engineering 3,	2 hours	Mech. Engineering 9,	2 hours
Mech. Engineering 2,	3 hours	Mech. Engineering 13,	3 hours
	—		—
	18 hours		16 hours

Summer Session

Metallurgy 1,	3 hours
Elect. Engineering *4b*,	3 hours
	—
	6 hours

Fourth Year

FIRST SEMESTER		SECOND SEMESTER	
Civil Engineering 9,	1 hour	Mech. Eng'g 10 or 11,*	3 hours
Mech. Engineering 7,	2 hours	Mech. Engineering 14,	2 hours
Mech. Engineering 8,	3 hours		—
Mech. Eng'g 10 or 11,*	3 hours		5 hours
Mech. Engineering 12,	3 hours	Electives	
	—	Thesis	
	12 hours		
Electives			

Total hours prescribed, 125. Required for graduation, 130 and a thesis.

After completing his third year of the above course a student may, if he desire, change to the course in Marine Engineering by taking the subjects indicated in § 119 during his fourth year.

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*One-half of the class each semester.

116. ELECTRICAL

Second Year

FIRST SEMESTER		SECOND SEMESTER	
French or German 1,	4 hours	French or German 2,	4 hours
Mathematics 3,	5 hours	English 1*a*,	2 hours
Physics 2,	5 hours	Mathematics 4,	5 hours
Physics 3*b*,	2 hours	Drawing 4,	3 hours
Shop Work 4*a*,	3 hours	Shop Work 1*b*,	2 hours
	—	Elect. Engineering 1,	2 hours
	19 hours		—
			18 hours

Third Year

FIRST SEMESTER		SECOND SEMESTER	
French or German 3,	4 hours	Mathematics 6,	2 hours
Mathematics 5,	3 hours	Shop Work 4*b*,	2 hours
Mech. Engineering 2,	3 hours	Civil Engineering 3,	2 hours
Mech. Engineering 4,	2 hours	Civil Engineering 5,	3 hours
Mech. Engineering 6,	2 hours	Mech. Engineering 5,	2 hours
Elect. Engineering 2,	4 hours	Elect. Engineering 3,	3 hours
	—	Elect. Engineering 4*a*,	4 hours
	18 hours		—
			18 hours

Summer Session

Shop Work 3*a*,	2 hours
Metallurgy 3,	3 hours
	—
	5 hours

Fourth Year

FIRST SEMESTER		SECOND SEMESTER	
Mech. Engineering 7,	2 hours	Elect. Engineering 8,	3 hours
Elect. Engineering 5,	4 hours		—
Elect. Engineering 6,	1 hour		3 hours
Elect. Engineering 7,	4 hours	Electives	
	—	Thesis	
	11 hours		
Electives			

Total hours prescribed, 120. Required for graduation, 130 and a thesis.

After completing his third year of the above course a student may, if he desire, change to the course in Marine Engineering by taking the subjects indicated in § 119 during his fourth year.

117.

CHEMICAL

Second Year

FIRST SEMESTER		SECOND SEMESTER	
French or German 1.	4 hours	French or German 2,	4 hours
Mathematics 3.	5 hours	Mathematics 4.	5 hours
Physics 2,	5 hours	Chemistry 3.	7 hours
Drawing 4,	3 hours		—
	—		16 hours
	17 hours		

Third Year

FIRST SEMESTER		SECOND SEMESTER	
French or German 3.	4 hours	English 1*a*,	2 hours
Chemistry 5.	5 hours	Physics 3*c*,	3 hours
Chemistry 7.	5 hours	Chemistry 28,	5 hours
Chemistry 33.	5 hours	Chemistry 38,	5 hours
	—		—
	19 hours		15 hours

Summer Session

Elect. Engineering 4*b*,	3 hours
Elective,	2 or 3 hours
	—
	5 or 6 hours

Fourth Year

FIRST SEMESTER		SECOND SEMESTER	
Metallurgy 1,	3 hours	Chemistry 39,	5 hours
Surveying 4,	1 hour	Mech. Engineering 6,	2 hours
Chemistry 35,	2 hours		—
Mech. Engineering 2.	3 hours		7 hours
Mech. Engineering 4.	2 hours	Electives	
Mech. Engineering 7,	2 hours	Thesis	
	—		
	13 hours		
Electives			

Total hours prescribed, 120. Required for graduation, 130 and a thesis.

118.

MARINE

Second Year

FIRST SEMESTER		SECOND SEMESTER	
French or German 1,	4 hours	French or German 2,	4 hours
Mathematics 3,	5 hours	English 1*a*,	2 hours
Physics 2,	5 hours	Mathematics 4,	5 hours
Mech. Engineering 1,	2 hours	Drawing 4,	3 hours
Shop Work 1*b*,	2 hours	Shop Work 3,	4 hours
		Naval Architecture 1,	1 hour
	18 hours		18 hours

Third Year

FIRST SEMESTER		SECOND SEMESTER	
French or German 3,	4 hours	Mathematics 6,	2 hours
Mathematics 5,	3 hours	Shop Work 3*a*,	2 hours
Physics 3*c*,	3 hours	Civil Engineering 5,	3 hours
Civil Engineering 3,	2 hours	Mech. Engineering 5,	2 hours
Mech. Engineering 2,	3 hours	Mech. Engineering 6,	2 hours
Mech. Engineering 4,	2 hours	Mech. Engineering 13,	3 hours
Naval Architecture 2,	2 hours	Naval Architecture 5,	2 hours
	19 hours		16 hours

Summer Session

Elect. Engineering 4*b*,	3 hours
Metallurgy 1,	3 hours
	6 hours

Fourth Year

FIRST SEMESTER		SECOND SEMESTER	
Surveying 4,	1 hour	Naval Architecture 4,	4 hours
Civil Engineering 9,	1 hour	Marine Engineering 9,	2 hours
Mech. Engineering 7,	2 hours	Naval Architecture 7,	2 hours
Mech. Engineering 9,	3 hours	Marine Engineering 11,	1 hour
Naval Architecture 3,	2 hours		
Marine Engineering 8,	2 hours		9 hours
Naval Architecture 6,	3 hours	Electives	
Marine Engineering 10,	1 hour	Thesis	
	15 hours		

Total hours prescribed, 130. Required for graduation, 130 and a thesis.

119. **Students who have completed three years of any one of the preceding courses except the chemical and marine courses may change to the course in Marine Engineering by taking the following work.**

Fourth Year

FIRST SEMESTER		SECOND SEMESTER	
Civil Engineering 9.	1 hour	Mech. Engineering 9,	2 hours
Mech. Engineering 7.	2 hours	Naval Architecture 4,	4 hours
Mech. Engineering 11,	3 hours	Marine Engines 9,	3 hours
Naval Architecture 1,	2 hours	Naval Architecture 7,	3 hours
Naval Architecture 3,	2 hours	Marine Engines 11,	1 hour
Marine Engines 8,	2 hours		—
Naval Architecture 6,	3 hours		13 hours
Marine Engines 10,	1 hour	Electives	
	—	Thesis	
	16 hours		

REQUIREMENTS FOR GRADUATION

The Degree of Bachelor of Science

120. To earn the degree of Bachelor of Science in civil, mechanical, electrical, chemical, or marine engineering, the student must secure *one hundred and thirty Hours of Credit** in a prescribed course of study, as given below, and must present a satisfactory *thesis*.† The diploma given indicates the line of study pursued. A time limit is not fixed; but four years is usually needed for the completion of the work required for the degree.

Bachelors of Arts, of this University, and graduates of any other reputable college, are excused from some portions of the general requirements, and are recommended for the same degree with the regular students upon completing the remaining requirements. This work can be done in two years, if the candidate has previously made considerable progress in mathematics and science. The culture imparted by classical or other liberal training will be found to have its uses for one engaged in engineering work, and previous discipline of the faculties in exact research will enable the professional student to master more easily the requirements of the course. All the time the student can devote to general studies before taking up specialties will be well spent.

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*For explanation of the term Hour of Credit see § 90, and for further information in regard to the courses prescribed for graduation, see §§ 93-111.

†Students entering after commencement 1904 must secure *one hundred and forty Hours of Credit*, six hours of which must be earned in one Summer Session, no thesis being required.

A choice between the five courses in engineering need not be made before the end of the second year.

An additional year of study, joined to a proper selection of electives, will enable a student to obtain the degree of Bachelor of Science in another course in Engineering.

GENERAL REQUIREMENTS*

121. The *general requirements* are as follows:

In French and German:—sixteen hours, to be elected as explained in note at bottom of page 52.
†In English:—Course 1.
In Mathematics:—Courses 1, 2, 3, 4.
In Physics:—Courses 1, 2.
In Chemistry:—Course 2.
In Drawing:—Courses 1, 4, 5.
†In Shop Practice:—Course 1.
In Mechanical Engineering:—Courses 2, 4, 7.

SPECIAL REQUIREMENTS

The *special requirements* in the several courses are as follows:

In Civil Engineering.

122. To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Civil Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Mathematics:—Courses 5, 6.
In Physics:—Course 3*c*.
In Mineralogy:—Course 1.
In Geology:—Course 6.
In Astronomy:—Course 4.
In Drawing:—Course 14.
In Surveying:—Courses 1, 2, 3, 5.
In Civil Engineering:—Courses 3, 4, 5, 6, 7, 8, 9, 15.
In Electrical Engineering:—Course 4*b*.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts:—an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

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*For students pursuing work under the *old order of studies,* see § 114.

†English 1 embraces old Courses 1 and 1*a*, and Shop Practice 1 embraces old Courses 1*a* and 2*a*. Special arrangements will be made for those students who have already completed a part of their work in these courses.

In Mechanical Engineering

123. To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Mechanical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requqirements* named above, courses as follows:

In Mathematics:—Courses 5, 6.
In Physics:—Course 3*c*.
In Metallurgy:—Course 1.
*In Shop Practice:—Courses 1, 1*b*, 3*a*, 3.
In Surveying:—Course 4.
In Civil Engineering:—Courses 3, 5, 9.
In Mechanical Engineering:—Courses 1, 5, 6, 8, 9, 10, 11, 12, 13, 14.
In Electrical Engineering:—Course 4*b*.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts:—an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

In Electrical Engineering

124. To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Electrical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Mathematics:—Courses 5, 6.
In Physics:—Course 3*b*.
*In Shop Practice:—Courses 1, 1*b*, 3*a*, 3.
In Civil Engineering:—Courses 3, 5.
In Mechanical Engineering:—Courses 5, 6.
In Electrical Engineering:—Courses 1, 2, 3, 4*a*, 5, 6, 7, 8.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts:—an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

In Chemical Engineering

125. To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Chemical Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Physics:—Course 3*c*.
In Chemistry:—Courses 3, 5, 7, 28, 33, 35, 38, 39.
In Metallurgy:—Course 1.
In Surveying:—Course 4.
In Mechanical Engineering:—Course 6.
In Electrical Engineering:—Course 4*b*.

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*Shop Practice 1 embraces old courses 1*a* and 2*a*, and Shop Practice 3 embraces old courses 4*a* and 4*b*. Special arrangements will be made for those students who have already completed a part of their work in these courses.

In Elective Studies, taken in the Department of Engineering, or in the Department of Literature, Science, and the Arts:—an amount sufficient to secure in all *one hundred and thirty Hours of Credit.*

In Marine Engineering

126. To obtain the recommendation of the Faculty for the degree of Bachelor of Science in Marine Engineering, the student must satisfactorily complete, in addition to the *thesis* and the *general requirements* named above, courses as follows:

In Mathematics:—Courses 5, 6.
In Physics:—Course 3*c*.
In Metallurgy:—Course 1.
*In Shop Practice:—Courses 1, 1*b*, 3*a*, 3.
In Surveying:—Course 4.
In Civil Engineering:—Courses 3, 5, 9.
In Mechanical Engineering:—Courses 1, 5, 6, 9, 13.
In Electrical Engineering:—Course 4*b*.
In Naval Architecture and Marine Engineering:—Courses 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11.
In all, 130 hours.

Or the student may take the civil, mechanical, or electrical course for three years and do the work stated in § 119 for the fourth year.

GRADUATE COURSES

The Degree of Master of Science

127. A candidate for the degree of Master of Science in this Department must have previously received the engineering degree of Bachelor of Science from this University, or, if graduated elsewhere, must satisfy the Faculty that he possesses equivalent attainments.

He must choose a *major* subject, which shall occupy one-half of his time, from the work given in this Department, and two *minor* subjects, each to occupy one-fourth of his time, to be selected from any work open to engineering students; all of the work, however, shall be subject to the approval of the Faculty. Study and residence for not less than one year will be required. Among the courses described on previous pages, the following are arranged primarily for graduates:

In Physics:—Courses 7, 10, 16.
In Civil Engineering:—Courses 11, 12, 13, 14, 16.
In Mechanical Engineering:—Courses 16 to 24, inclusive.
In Electrical Engineering:—Course 9.
Chemical Engineering:—Course 37.
In Naval Architecture and Marine Engineering:—Courses 12, 13, 14, 15, 16.

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*See note on preceding page.

If a candidate for the degree of Master of Science desires to have his work count towards the degree of Civil Engineer, Mechanical Engineer, Electrical Engineer, Chemical Engineer, Marine Engineer, or Naval Architect the major subject must be taken in the course in which he took his bachelor's degree, and he must submit a satisfactory thesis before such degree as Engineer will be conferred.

The Degrees of Civil Engineer, Mechanical Engineer, Electrical Engineer, Chemical Engineer, Marine Engineer, and Naval Architect

128. The conditions under which the degree of Engineer may be obtained by graduates of this University in the Department of Engineering are as follows:

1. The candidate must furnish satisfactory evidence that he has pursued further technical studies along the lines of his profession the equivalent in amount of one year's work in the University. This work need not necessarily be consecutive. It may be done at the University or in *absentia.* In either case a prescribed course of study must be approved in advance by the Faculty. If the candidate resides at the University he can if he desires pursue his studies with a view to obtaining the degree of Master of Science on completion of the prescribed course of study. See § 127.
2. The candidate must have been engaged in professional work in positions of *responsibility* for at least one year since graduation, and must furnish a detailed account of his entire professional career one month before the date of the annual commencement at which he expects to receive the degree.
3. The candidate must prepare a satisfactory thesis on some engineering topic to be presented at the same time as the account of his professional experience, one month before commencement. The subject of the thesis must be approved in advance by the Faculty.
4. The candidate must, before beginning his work for the degree of Engineer, make formal application and register in the Department. A registration fee of $10 is required, which should accompany the application. A diploma fee of $10 is also required, which must be paid one month before Commencement.

129. SCHEDULE OF EXAMINATIONS

In 1904-1905 the Examination Periods begin as follows: First Semester, Friday, Feb. 3; Second Semester, Friday, June 9.

Time of Exercise*	Monday 8	Monday 9	Monday 10	Monday 11	Monday 1	Monday 2	Monday 3
Time of Examination	Monday 8-10	Tuesday 8-10	Thursday 8-10	Friday 8-10	Thursday 4-6	Tuesday 2-4	Wednesday 2-4
Time of Exercise	Tuesday 8	Tuesday 9	Tuesday 10	Tuesday 11	Tuesday 1	Tuesday 2	Tuesday 3
Time of Examination	Saturday 8-10	Wednesday 8-10	Monday 2-4	Thursday 2-4	Friday 4-6	Saturday 4-6	Friday 2-4
Time of Exercise	Wednesday 8	Wednesday 9	Wednesday 10	Wednesday 11	Wednesday 1	Wednesday 2	Wednesday 3
Time of Examination	Saturday 10-12	Monday 10-12	Friday 10-12	Wednesday 10-12	Monday 4-6	Tuesday 10-12	Thursday 10-12

*Note: By the **Time of Exercise** is meant the time of the first exercise of the week in any given course. For example: If a course is given Monday at 3, Wednesday at 3, and Friday at 10, it is said to be given **Monday at 3.** By referring to Monday 3, in the schedule, it will be seen that the examination falls upon Wednesday 2-4. In courses not provided for, the examinations may be held Saturday 2-4, Tuesday 4-6, or Wednesday 4-6, without conflicting with the schedule.

130. REGISTER OF STUDENTS FOR THE YEAR 1903-4.

RESIDENT GRADUATES

NAME	RESIDENCE
Austin Perry Biggs, B.S. [M.E.], 1903,	*Ann Arbor.*
George Grant, Jr., B.S. [M.E.], 1903,	*Saginaw.*

CANDIDATES FOR ADVANCED DEGREE STUDYING IN ABSENTIA

NAME	RESIDENCE
Sergius Paul Grace, B.S. [E.E.], 1896,	*Pittsburgh, Pa.*
Clarence William Hubbell, B.S. [C.E.], 1893,	*Detroit.*
Andrew Horace McDougall, B.S. [M.E.],1901,	*Harvey, Ill.*
Rollo Glenroy Manning, B.S. [C.E.], 1890,	*Toledo, Ohio.*
William Lincoln Miggett, B.S. [M.E.], 1899	*Ann Arbor.*
Herbert Albion Moody, B.S. [M.E.], 1898,	*Chicago, Ill.*
Alfred Latimer Newton, B.S. [C.E.], 1901,	*Chicago, Ill.*
Frederick Charles Noble, B.S. [C.E.], 1894,	*Brooklyn, N. Y.*
John Castelar Parker, B.S. [M.E.], 1901, A.M., 1902.	*Schenectady, N. Y.*
Henry Lumsden Woolfenden, B.S. [E.E.], 1896, M.S., 1897,	*Denver, Colo.*

UNDERGRADUATES*

NAME	COURSE	CREDIT	RESIDENCE
Arthur Alger Abel,		8	*Ypsilanti.*
Samuel Black Adams,			*Buffalo, N. Y.*
Harley Clifford Alger,	M	38	*Hillsdale.*
William Chisholm Allan,	M	27	*Cleveland, O.*
Herbert Dunning Allen,			*Benton Harbor.*
Louis Heath Allen,	Ch	62	*Grosse Ile.*
Stanley Rindge Allen,	S	34	*Grand Rapids.*

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*The letters in the column headed Course indicate the line of work the student has chosen to pursue: C denoting civil engineering; M, mechanical engineering; E, electrical engineering; Ch, chemical engineering; Mar, marine engineering; S, miscellaneous studies not leading to any degree. As students are not asked to make choice of course until the beginning of their second year, the absence of a letter indicates that the student is in his first year. The figures in the column headed Credit indicate the number of hours of work taken by the student prior to the beginning of the current academic year, 1903-4, and completed without conditions, or credited to him on advanced standing. By an hour of work is meant the equivalent of one exercise a week for one semester. A dagger (†) preceding a student's name indicates that he also pursued studies, for the whole or a part of the year, in some other Department of the University.

William Henry Allen, Jr.,	Ch	119	*Grosse Ile.*
Courtenay Derby Allington,	M	29	*Saginaw.*
Maxwell Alpern,	M	31	*Alpena.*
Charles Wilkins Ambrose,		6	*Bay City.*
Charles Waldo Anderson,		15	*Albion.*
Frank Stuart Anderson,		26	*Evanston, Ill.*
Niels Malander Anderson,	S	27	*Fountain Green, Ut.*
Graydon Roy Andrew,	M	34	*Grand Rapids,*
Robert Edmund Andrews, A.B.,	C	97	*Bay City,*
Egmont Benjamin Arnold,	M	105	*Ann Arbor.*
Santiago Artiaga,	C	134	*Manila, P. I.*
Winfield K. Ash,		6	*Saint Johns.*
Robert Henry Atkinson,		6	*Norvell,*
Cassius Bruce Avery,	S	24	*Howell,*
Bert Wise Bachtel,	M	119	*Flint.*
Edward Kennedy Bacon,		6	*Denver, Col.*
Louis Rudolph Bailey,	C	30	*Big Rapids.*
Jesse Burdette Bain,		14	*Kennedy, N. Y.*
Burton Adams Baker,	E	29	*Lansing.*
Ray Douglas Baker,		8	*Fairfield.*
Arthur Lee Baldwin,	M	27	*Coldwater.*
Albert Powers Ball,			*Grand Rapids.*
Samuel Ball, A.B.,			*Grand Rapids.*
Harold Gillespie Bandfield.	E	70	*Portland.*
Newell Barnard,	M	33	*Saginaw, W. S.*
Joel Martin Barnes,	Ch	72	*Qnincy.*
Bird Lee Barns,	E	55	*Petoskey.*
Lewis Alton Barrack,	E	117	*Williamston.*
Roland Benner Barrett,	C	62	*Adrian.*
Walter Aldrich Barrett,	M	108	*Fort Wayne, Ind.*
John Sergeant Barstow,	M	66	*Grand Rapids.*
Carleton Fred Bartlett,		3	*Ann Arbor.*
Harry Skinner Bartlett,		9	*Detroit.*
John Rogers Bartlett,	C	116	*Chicago, Ill.*
John Warren Barton,	E	34	*Sturgis.*
Harold Eugene Beard,	C	54	*Kansas City, Mo.*
Roy Moses Beardslee,			*Greenville.*
Walter Cooley Becker,		12	*Chicago, Ill.*
Herbert Manning Beechinor,	E	36	*Mt. Vernon, N. Y.*
Roy Beechler,		29	*Ithaca.*
John Wesley Bell,	C	68	*Eastlake.*
Robert Meredith Bellman,		24	*Toledo, O.*
George Llewellyn Benbow,		3	*Amsterdam, N. Y.*
Walter Sewell Bennett,	E	70	*Plymouth.*
Gerrit Bergmans.		21	*Sneek, Holland.*
Walter Stewart Berry,			*Glendale, O.*
Lawrence Howard Bertsch, A.B., *Indiana University,*		25	*Cambridge City, Ind.*

Rolla Lavante Bigelow,	C	90	*Owosso.*
Carroll Biggs,	C	106	*Grand Rapids.*
Carl Otto Bjork,		6	*Chicago, Ill.*
David Theodore Bjork,	C	62	*Chicago, Ill.*
George Wilsey Blackinton,	M	118	*Flint.*
Walter Kellogg Blakeslee,	M	54	*Clinton, N. Y.*
Birdsil Edwin Blanchard,	E	113	*Greenville.*
Frank Walker Bliss,		9	*Niles.*
Homer Newell Bliss,		6	*Buffalo, N. Y.*
Theodore Bohon Bodell,	M	74	*Auburn, N. Y.*
Ellis Moss Bonney,	Ch	27	*Chicago, Ill.*
Roy Edmund Boomer,		3	*Ann Arbor.*
Cornelius William Boot,	E	26	*Holland.*
Luke Connable Bootes,		6	*Jackson.*
Robert Lee Boughton,			*Battle Creek.*
James Frederic Bourquin,	M	118	*Detroit.*
Lawrence Frederick Bowman,		5	*Duluth, Minn.*
Guy Bowser,			*Goshen, Ind.*
Merlin Boyd,		6	*Detroit.*
Patrick James Boyle,	M	37	*Brainerd, Minn.*
Wilber Irving Boyles,		6	*Charlotte.*
Claude Brigham Boynton,	M	46	*Muskegon.*
Grant David Bradshaw,	M	119	*Ann Arbor*
Samuel Craighead Brandon,	M	38	*Detroit.*
Ernest Leroy Brandt,	C	29	*Toledo, O.*
Benjamin Nathan Braun, B.S.,	M	14	*Ann Arbor.*
Arthur Edward Brems,		12	*Ypsilanti.*
Eugene S. Brewer,	E	110	*Owosso.*
Harry Leon Brightman,		6	*Ann Arbor.*
Percy Wellington Brilhart,	C	28	*Indiana, Pa.*
L. Roy Brink,			*Cannonsburg.*
Arthur Wellington Brock, Jr.,		9	*Alma.*
Henry Holbert Brodhead,			*Buffalo, N. Y.*
Hugh Brodie,		6	*Jacksonville, Fla.*
Norton Townshend Brotherton,		18	*Detroit.*
Harry Arthur Brown,	E	68	*Ann Arbor.*
James Arthur Brown,	M	88	*Sault Ste. Marie.*
Worley Jesse Brown,			*Sterling, Ill.*
Charles Lowman Browne,			*Aberdeen, S. Dak.*
Albert Ernest Brugger,			*Columbus, Neb,*
†Albert Ernest Bullock,			*Muskegon.*
Albert Comstock Burch,		3	*Grand Rapids.*
Andrew Gano Burt, Jr.,		4	*Chicago, Ill.*
Frank Burton,			*Detroit.*
Louis Edward Burton,	M	54	*Detroit.*
Eli Franklin Bush,	E	38	*Hudson.*
Ray Elon Bushnell,		14	*Joppa.*
Louis Butler,	E	31	*Kendall, Mont.*

Robert Earl Butler,	S		*Ann Arbor.*
Arthur Blaine Caldwell,			*York, N. Y.*
Alexander Lagon Campbell,	M	65	*Angell.*
Harvey Blaine Campbell,		11	*Battle Creek.*
Johhn Wood Campbell,	E	32	*Napoleon, O.*
Valreen Colin Campbell,	C	107	*Saint Thomas, Ont.*
Will Ferris Campbell,			*Cadillac.*
Clifton O'Neal Carey, B.S., *Haverford College,*		8	*Wilmington, O.*
Emory Carhart,		6	*Ann Arbor.*
Orville Berton Carlisle,	C	63	*Shelby.*
Augustus Carrier, Ph.G., *Detroit Coll. of Pharmacy,*	E	30	*Detroit.*
Edgar McMurray Carrothers,	M	20	*Toledo, O.*
George Miller Carter,			*Jackson.*
Roger Stevens Cathcart,			*Bay City.*
Grover William Champlain,	E	35	*Dunkirk, N. Y.*
Henry Morrison Chapin,		18	*Ashtabula, O.*
Claude Edward Chappell,		18	*Charlotte.*
Irwin Goodrich Chase,	C	62	*Saint Louis, Mo.*
Charles Timothy Chenevert,			*Defiance, O.*
Bonnell Wetmore Clark,	Mar	62	*Adrian.*
George Rogers Clark,			*Ann Arbor.*
George Winfred Clark,	E	40	*Grand Rapids.*
William Dennison Clark,		9	*Detroit.*
Kinsley Napier Clarke,	M	51	*Chicago, Ill.*
David Homer Clary,	Ch	106	*Monroeville, O.*
Henry Joseph Clemens,	E	109	*Detroit.*
Carl Howard Clement,		21	*Toledo, O.*
Charles Clute,			*Ann Arbor.*
John Knox Cochran,	C	116	*Ann Arbor.*
Elmer J. Codner,	M	33	*Auburn, N. Y.*
Bela Laverne Cogshall,	M	34	*Muskegon.*
Leon Christian Coller,	E	70	*Detroit.*
Hervey Adolph Colvin,		6	*Adrain.*
Nathan Roy Cook,		6	*Jackson.*
Robert Wheeler Cook,		6	*Hastings.*
William George Cook,	C	115	*Grand Rapids.*
Ross Miller Coomer,	C	67	*West Bay City.*
Thurlow Emmett Coon, A.B.,	M	114	*Ann Arbor.*
Herbert Rhemson Cornell,		11	*Mount Clemens.*
Harold Hawley Corson,		6	*Birmingham.*
Carl Talcott Cotter,	M	119	*Toledo, O.*
Reginald Petre Courtis,		6	*Detroit.*
Edward James Creighton,	C	34	*Franklin, Pa.*
Cris Cron,	E	33	*Manistee.*
Fred Rudolph Cron,	C	35	*Manistee.*
Charles Henry Croom,	E	44	*Jackson.*

Harold B. Culbertson,	M	33	*Charlotte.*
George Aekmaar Cunningham,	C	99	*Indiana, Pa.*
Claude Clayton Curtis,		6	*Battle Creek.*
John Spencer Curtis,		6	*Pueblo, Col.*
Martin Hubert Daane,			*Grand Rapids.*
Ernest Welker Dales,			*Grand Rapids.*
Allen Lynn Darr,	C	120	*Tacoma, Wash.*
Frank Patrick Davey,	C	41	*Imlay City.*
Thomas Stephen Davies,			*Detroit.*
Philip Chapin Davis,	M	50	*Kalamazoo.*
Robert Austin Davison,			*Alpena.*
Clarence Whiting Davock,		6	*Detroit.*
Archie Smith Day,			*Youngsville, Pa.*
Arthur James Decker,	C	65	*Marlette.*
Arthur Dee,		6	*Detroit.*
William Harmon DeGraff,		6	*Detroit.*
Isaac DePagter,	C	35	*Grand Rapids.*
Charles Detweiler,		9	*Leavenworth, Kan.*
Rollo William Detwiler,	M	67	*Owosso.*
John Henry DeVisser,		18	*Kalamazoo.*
Ralph Devries,			*Holland.*
Henry Cadby Dewey,	C	79	*Manchester, N. Y.*
Edward Stanton Dibble,		6	*Saginaw.*
Harold Shields Dickerson,	E	78	*Grand Rapids.*
*Thornton Dickinson,			*Detroit.*
Robert Rufus Dinsmore,		8	*Pontiac.*
William Henry Distin, Jr.,	M	67	*Detroit.*
Wilson Irving Doan,			*North Bend, Neb.*
Otto Henry Doane,		15	*Forest Hill.*
Edwin Robert Dobbin,	M	36	*Geneva, N. Y.*
Robert Moxley Dodge,			*Moscow, N. Y.*
Myron George Doll,	Ch	116	*Erie, Pa.*
Gerrit Cornelius Dooge,	C	113	*Grand Rapids.*
Everet Eugene Dorris,		8	*Quincy.*
Harry Pine Drake,	C	111	*Detroit.*
Ralph L. Drake,	M	63	*Ann Arbor.*
Herman Otto Dratz,	M	34	*Muskegon.*
Harry Lane Dresser,		6	*Ann Arbor.*
Howard Blaine Drollinger,		5	*Grand Rapids.*
John Adams Dunford, B.S., *Michigan Agricultural Coll.*,		21	*Long Rapids.*
Byron William Dunham, B.S., *Kalamazoo College,*	M	20	*Oshtemo.*
Arthur Fink Dunnebacke,		6	*Lansing.*
†Willis Fayette Durlin,	E	27	*Erie, Pa.*
Allan Theodore Dusenbury,	M	112	*Mount Pleasant.*

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*Deceased.

Frank Adelbert Dwelle,		14	*Jackson.*
George Lewis Earle,		9	*Detroit.*
Roy Jay Easton,			*Ann Arbor.*
Oscar Alfred Eberbach,	Ch	39	*Ann Arbor.*
Ralph Lewis Edwards,	C	37	*Hinsdale, Ill.*
Walter Emanuel Ehrman,	C	46	*Chicago, Ill.*
Fred Woodworth Ellis,			*Olivet.*
Robert Bisbee Elsworth,	M	67	*Wayne.*
Arthur Dwight Elwell,	M	32	*Standish.*
Seth Harrison Ely,	E	32	*Rutherford, N. J.*
Frank Collins Emerson,	C	126	*Saginaw.*
Warren Edwards Emley,	Ch	45	*Philadelphia, Pa.*
John Emil Erickson,		6	*Marquette.*
Raymond Orville Ernsberger,			*Three Rivers.*
John Edward Evans,	C	111	*Ypsilanti.*
Walter Leonard Eyke,		13	*Muskegon.*
Charles Reed Faben,		8	*Toledo, O.*
George Stokes Fanning,	C	38	*Detroit.*
Galusha Hamilton Fay,	M	27	*Los Angeles, Cal.*
John Morton Fedewa,		6	*Saint Johns.*
Perry Augustus Fellows,	C	77	*Albion.*
John Alexander Ferguson, A.B.,	Ch	124	*Detroit.*
Robert Jay Ferris,	E	67	*Greenville.*
Albert Frederick Fillerup,	S	49	*Vineyard, Utah.*
Earl Alpheus Finkbeiner,	M	110	*Chelsea.*
Alfred Carrel Finney,	E	116	*Ann Arbor.*
Carl Herman Frederick Fischer,	Ch	72	*Cincinnati, O.*
Harold Clinton Fish,		6	*Allegan.*
Clarence Andrew Fisher,	C	34	*Bay City.*
Martin Rankin Fisher,	C	35	*Inkster.*
John Arthur Fishleigh, Jr.,			*Chicago, Ill.*
Victor Benedict Fitzpatrick,			*Ann Arbor.*
Robert Stephenson Fleshiem,	E	110	*Evanston, Ill.*
Henry Eells Fletcher,		17	*Detroit.*
Horatio Keeler Florentine,	M	16	*Chicago, Ill.*
William Henry Foote,	M	58	*Chicago, Ill.*
James Forbes,		6	*Port Huron.*
Albert Robinson Ford,		6	*Jackson.*
Earl Andrew Forkner,	E	121	*Anderson, Ind.*
Guy Thomas Foster,			*Dayton, O.*
Frank Roscoe Fowles,	M	37	*Auburn, Me.*
Maurice Winslow Fox,	M	37	*Detroit.*
Harry Marshall Francis,	E	61	*Hillsboro, N. Dak.*
Howard Lee Franklin,			*North Collins, N. Y.*
Albert Phillip Frapwell,			*Greenland.*
David Ross Fraser, Jr.	M	128	*Chicago, Ill.*

Glenn Alonzo Freeman,		6	*Ionia.*
Harold Blaine French,	E	60	*South Haven.*
Robert Wilton French,		6	*Ann Arbor.*
Jesse Louis Frink,		6	*Port Huron.*
Claude Jesse Fry,	M	79	*Grand Rapids.*
Charles Arthur Fuller,	M	109	*Vermontville.*
William Henry Fürst,		14	*Chicago, Ill.*
James Stewart Fulton,	M	75	*Steubenville, O.*
Stanley Lawrence Fyfe,	M	33	*Saint Joseph.*
Joseph Gale,	C	63	*Ann Arbor.*
Thomas Griswold Gale,	M	113	*Saginaw.*
Ralph Galt,	Ch	64	*De Kalb, Ill.*
Jésus Garcia,			*Allende, Mexico.*
Fernando Garcinava,			*Purisima, Mexico.*
Lester John Garlock,	E	28	*Howell.*
John Carlisle Garrels,		6	*Detroit.*
John Antony Garrett,	M	108	*New Florence, Mo.*
Clyde Baker Gass,		6	*Ypsilanti.*
Albert Lewis Gayer,	E	70	*Flint.*
Edwin LeRoy Gemmill,	M	74	*Sharpsville, Pa.*
Ernest Lewis Gentz,		6	*Plymouth.*
Henry Georg,		6	*Ann Arbor.*
Ralph Wadhams George,	M	45	*Ypsilanti.*
Roy Wellington Gifford,	M	39	*Cass City.*
William Arthur Gifford,	M	40	*Cass City.*
John Orpheus Gilbert,	E	64	*Medina, N. Y.*
George Woodbury Gilkey,	M	114	*Plainwell.*
Irving Leo Gill,		7	*Grand Rapids.*
Charles E. Gillette,		3	*Niles.*
Earl Mansfield Gladden,	E	38	*Owosso.*
Earl D. Glidden,	M	67	*Mattawan.*
John Lee Goble,	Mar	76	*Oswego, N. Y.*
*Cecil Gooding,	M	72	*Ann Arbor.*
Ralph Othniel Gooding,	E	72	*Ann Arbor.*
Irving Dean Goodwin,	C	35	*Owosso.*
Lee Reeves Goodwin,	Ch	35	*Owosso.*
Jacob David Gordon,	E	39	*Detroit.*
Ray Foster Gordon,	C	33	*Howell.*
Francis James Gormely,		6	*Newberry.*
Fred Q. Gorton,		17	*Ypsilanti.*
Nelson Barnes Gosline,		8	*Chicago, Ill.*
Robert Warren Gotshall,	C	43	*Toledo, O.*
Carl Louis Gottschalk,	E	31	*Quincy.*
George Gilbert Grace,	C	73	*Howell.*
Douglas Arnold Graham,			*Chicago, Ill.*
Ralph Samuel Gram,	C	67	*Menominee.*

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*Deceased

Joseph John Gramling,			*Toledo, O.*
John Martin Grant,	C	35	*Alpena.*
Wilbur H. Grant,	S	23	*Aurora, Ill.*
Alexander MacDonald Graver,	M	76	*Chicago, Ill.*
Herbert Spencer Graver,	C	122	*Chicago, Ill.*
Charles Kingman Grear,	C	39	*Albion, N. Y.*
Arthur Crandall Green,	M	108	*Corunna.*
Edward Guy Green,	C	46	*Charlevoix.*
Guy Stevens Greene,			*Ann Arbor.*
Mark Harris Gregg,	M	111	*Ann Arbor.*
Edwin Loomis Grimes,			*Davenport, Ia.*
George Washington Haggerson,	C	92	*Menominee.*
Gilbert Ray Haigh,	M	71	*Port Huron.*
Bertram V. R. Hall,	C	130	*Lawton.*
Gerald Packard Hall,			*Auburn, Me.*
Morris Albert Hall,	M	111	*Buffalo, N. Y.*
Omar Israel Hall,	M	100	*Ann Arbor.*
Rolland Servis Hall,	C	107	*Ann Arbor.*
Wilton St. John Hall,	M	34	*Waverly, N. Y.*
William Albert Hamilton, A.B., *Cornell University,*	M	46	*Seattle, Wash.*
Harry Stevens Hammond,		9	*Chicago, Ill.*
Charles Augustus Handeyside,	C	59	*Wayne.*
Fred Kramer Handy,			*Bay City.*
Herman Henry Hanink,			*Grand Rapids.*
Charles Ralph Hannan, Jr.,		6	*Council Bluffs, Ia.*
Sidney Twitchell Harding,	C	53	*Wichita, Kan.*
George Lloyd Harman,	M	34	*Bay City.*
Leonard Stanley Harmer,		4	*Manistee.*
Harry Alvin Harris,	E	101	*Cheboygan.*
William Frank Harris,	C	39	*Bay City.*
Russell Edwin Harrison,	C	79	*Ann Arbor.*
Donald Theodore Hastings,		6	*Detroit.*
Edward Hatterchide,	S	16	*Fort Thomas, Ky.*
Walter Irving Hautau,		13	*Chicago, Ill.*
Ransom Smith Hawley,	E	29	*Ludington.*
Charles Edward Hayes,	C	67	*Saginaw.*
Eli Lewis Hayes,	M	54	*Reed City.*
James Jacob Haynes,		6	*Port Huron.*
Ralph Smith Heath,			*New Baltimore.*
Max Philip Heavenrich,	C	104	*Saginaw.*
Alvin John Heintz,	E	65	*Petoskey.*
William Hendrie, Jr.,	E	23	*Detroit.*
James Rowley Hendry,	C	39	*Ann Arbor.*
Percy Rosacrans Hicks,		6	*Alpena.*
Ross Earle Hicks,	M	71	*Friendship, N. Y.*
Robert Marshall Hidey,		13	*Mount Pleasant.*
Roy Olin Higgs,		3	*Forestville, N. Y.*

Frank Cyrus Higley,	C	33	*Ann Arbor.*
Ross Daniel Hildebrant,	C	34	*Howell.*
Lyle Steen Hill,	E	31	*Berlin Heights, O.*
Clarence Arnold Hills,			*Torrington, Conn.*
Ross Oel Hinkle,	E	32	*Fenton.*
Milton Leroy Hinkley,			*Orchard Lake.*
Jesse Frederick Hirschman,	S	18	*Detroit.*
William Robert Hoeck,	M	35	*Elkhart, Ind.*
Edward Lawrence Hogan,	E	119	*Saint Johns.*
William Manville Hogle,	M	94	*Decorah, Ia.*
Ray Hoisington,			*Durand.*
Henry Raymond Holcomb,			*Northville.*
Howard Kingsbury Holland,			*Cassopolis.*
†Francis Hiel Hollister,			*Cambridge, N. Y.*
Arthur Holmes,	M	112	*Ypsilanti.*
Harold Wheeler Holmes,		14	*Detroit.*
Louis Norman Holthe,		19	*Muskegon.*
Fred Holloway Hood, D.D.S.,			*Ann Arbor.*
Harold Hooker,	C	111	*Spokane, Wash.*
Joseph Clyde Hoover,			*Keuka, N. Y.*
Elwyn Will Hopkins,	E	23	*Jackson.*
George Hayes Hopkins,	C	24	*Lansing.*
John Henry Hoppin,		6	*Niles.*
Clayton Irvin Hoppough,		6	*Smyrna.*
Samuel Horner,	C	124	*Reed City.*
Max Bailey Horton,	C	28	*Detroit.*
William O. Houston,	C	104	*Detroit.*
Horace Henry Howard,			*Churchville, N. Y.*
Franklin Johnson Howes,	C	40	*Decatur, Ill.*
Howard Benson Howie,	C	89	*Sault Ste. Marie.*
Sidney Merrill Hoyt,		11	*Jamestown, N. Y.*
Arthur Theodore Hunt,	E	40	*Ann Arbor.*
John Herman Hunt,	E	76	*Saranac.*
Ormond Edson Hunt,		6	*Saranac.*
Gustavus Adolphus Hyde, Jr.,		20	*Cleveland, O.*
Edwin Foy Hyland,			*Butte, Mont.*
Thomas Martin Jackson,	M	39	*Saginaw.*
John Henry James,	M	30	*Detroit.*
Cyril Methodius Jansky,	E	99	*Ann Arbor.*
Guy Whitcomb Joclyn,	C	34	*Leavenworth, Kan.*
Cortes Johnson,	C	105	*La Grange, Mo.*
Oliver Fred Johnson,		6	*Greenville.*
William Demorest Johnston,	E	55	*Milford.*
Clarence Ricker Jones,	M	68	*Detroit.*
Forrest Samuel Jones,			*Alpena.*
Carl Jonathan Josenhans,	C	43	*Saline.*
Milo Oliver Judd,			*Ann Arbor.*
Frederick Charles Kahle, Jr.,	E	42	*Menominee.*

Henry Karsten,	C	27	*Zeeland.*
George Irving Keal,	M	37	*Dexter.*
Edward Daniel Kearns, A.B., *Detroit College,*	E	26	*Ann Arbor.*
Ralph Whittlesey Keeler,		9	*Detroit.*
Clarence Lloyd Keller,	E	112	*Detroit.*
Charles Dane Kelly,	M	32	*Mount Clemens.*
†William Kline Kelsey,		9	*Toledo, O.*
Warren Francis Kendrick,	M	37	*Ann Arbor.*
Clifford Stewart Kennedy,	E	35	*Niles.*
Stiles Compton Kennedy,		8	*Saint Louis.*
Walter Brown Kern,	M	24	*Dayton, O.*
Harry Price Kerr,	Ch	51	*Buffalo, N. Y.*
Loran Alvaredo Kerr, A.B., *Ohio Wesleyan University,*			*Tippecanoe City, O.*
Walter Cole Keys,		9	*Glendale, O.*
Daniel William Kimball,	C	98	*Grand Rapids.*
Clyde Arthur Kindig,			*Akron, O.*
Justin Thomas Kingdon,	C	38	*Detroit.*
Stuart Bowler Kingsbury,	Mar	104	*Ann Arbor.*
Clarence Elmer Kinney,	S	45	*Kansas City, Mo.*
Howard Kipp,			*Greenville.*
Harold Eli Kirby,			*Galesburg.*
George Alfred Kirley,	C	35	*Sheldon, Vt.*
Lester Kirschbraun,	Ch	108	*Omaha, Neb.*
Charles Samuel Kisinger, B.S., *Adrian College,*	C	60	*Adrian.*
Karl Kingsley Kitchen,			*Cleveland, O.*
William Kletzer,	E	87	*Grand Rapids.*
Frederick Evoy Kneip,		27	*Ypsilanti.*
Walter Francis Kneip,	M	106	*Ypsilanti.*
William Clark Knight,	Mar	34	*Westboro, Mass.*
Clarence Carl Knipmeyer,			*Higginsville, Mo.*
Edward Moore Knox,		3	*Ann Arbor.*
Martin Weston Kramer,	Ch	40	*Elk Rapids.*
Milton Harris Kramer,			*Cadillac.*
Clarence Henry Kremers,	M	34	*Holland.*
Leo Crane Kugel,			*Sandusky, O.*
George Hans Kuhn,		4	*Chicago, Ill.*
Arthur Emil Kusterer,	C	75	*Grand Rapids.*
Howard Angell Ladue,	S	7	*Detroit.*
Lewis West Lamb,		6	*Greenville.*
George William Lamke,	E	40	*Detroit.*
Walter Henry Lane,		9	*Friendship, N. Y.*
Leon Karl Laney,	M	46	*Lima, O.*
Joseph Kerr Langfitt,			*Allegheny, Pa.*
Samuel Pierpont Langley,		13	*Cleveland, O.*
Henry Larsen,	M	38	*Eastlake.*

l Whiting Lathrop,	M	76	*Jackson.*
r Clarke Lathrop,	Mar	26	*Swanton, O.*
Boyd Lathy,	S		*Upper Alton, Ill.*
nce William Lawr,	Ch	22	*Elk Rapids.*
Burt Lawrason,			*Harbor Springs.*
Edmund Lawrence,	M	17	*Ypsilanti.*
e McNutt Lazell,	C	65	*Big Rapids.*
Ray Leffler,		5	*Naperville, Ill.*
r Edward Legg,		6	*Coldwater.*
awyer Leland,		26	*Ann Arbor.*
Harrison Levene,		6	*Detroit.*
lph Lewen,	C	71	*Detroit.*
Hamilton Lewis,	E	70	*Flint.*
ington Bart Lewis,		6	*Marquette.*
es Clyde Littlebrant,	E	30	*Albion, N. Y.*
Willett Lobdell,			*Flat Rock.*
n Arthur Lohmiller,		26	*Ann Arbor.*
tt John Lovett,	M	33	*Chicago, Ill.*
ht Everard Lowell,	M	52	*Auburn, Me.*
min James Lugers,	M	31	*Holland.*
John Lumsden,	C	34	*Ann Arbor.*
les Andrew Lund,			*Spokane, Wash.*
Lussky,	E	14	*Chicago, Ill.*
Milton Luttenton,		8	*Jackson.*
d Samuel Lyndon,	E	28	*Plymouth.*
Elliott McAfee,	M	112	*Kenilworth, Ill.*
m Coryell McBain,	M	112	*Grand Rapids.*
Alexander McCarthy,			*Kingsley.*
e Bernard McClelland,			*Tallman.*
Lyle McCulloch,			*Macomb, Ill.*
r Tremaine MacDonald,	C	71	*Butte, Mont.*
rd Joseph McDonnell,	M	26	*Port Huron.*
Eggleso McDonnell,	M	100	*Port Huron.*
nas McDowell, Jr.,			*Niagara Falls, N. Y.*
t Bruce McFarlan,			*Flint.*
Edward McGowan,			*Watertown, Conn.*
Francis MacKey,			*Newberry.*
s Raymond Macklem,	C	37	*Marlette.*
d Alexander McKenzie,			*Ann Arbor.*
Angus McKillican,		6	*Escanaba.*
Mussey McLean,	C	122	*Glendale, O.*
G. McLean,	E	36	*Owosso.*
m Neil McLeod,			*Newberry.*
e Hathaway McMullen,			*Grand Rapids.*
William McMullen,	M	107	*Grand Rapids.*
Wallace McOmber,			*Ann Arbor.*

Deceased.

David MacRitchie,		6	*Hillsdale.*
Clement Paul Malona,		11	*Kennedy, N. Y.*
Aden J. Manly,	M	72	*Deerfield.*
John Royal Mansfield,	M	130	*Bay City.*
Ferdinand William Marschner, Jr.,			*Detroit.*
William Joseph Matthews,	C	105	*Chicago, Ill.*
Robert Clyde Maxwell,		31	*Worthington, Pa.*
William Burgess May,	C	73	*Jackson.*
Oscar Franklin Mead, B.S., *Michigan Agricultural Coll.,*			*Detroit.*
Walter Thomas Mead., A.B., *University of Chicago,*			*Kalamazoo.*
William Henry Meese,	E	60	*Michigan City, Ind.*
George August Meier,		6	*Whittaker.*
Carl Edward Mensing,	M	26	*Chelsea.*
Horace Guy Merrick,	C	70	*Manistee.*
John Leonard Mess,			*Benton Harbor.*
Arthur Alexander Meyer,		6	*Detroit.*
John Louis Meyfarth,	Ch	37	*Jackson.*
Harry Elmer Mick,		2	*Goshen, Ind.*
Perry Kay Miller,		3	*Salamanca, N. Y.*
Carl Glover Milligan,		6	*Bradford, Pa.*
Carl Arthur Millis,		6	*Waterport, N.*
Adelbert Philo Mills,	C	34	*Tecumseh.*
Arthur James Mills,	C	29	*Chicago, Ill.*
Bradley Harold Mills,		6	*Mt. Vernon, N.*
Oscar Leroy Mills,		8	*Chicago, Ill.*
Robert Ellsworth Monagle,		16	*Stanley, N. Y.*
Hubert Howard Montague,	E	109	*Traverse City.*
Francis Alexander Montrose,		6	*Alpena.*
Lucian Selwyn Moore, Jr.,		3	*Detroit.*
William George Moore,	S	12	*Portsmouth, O.*
Cassus Arden Morford,		41	*Olivet.*
Stuart Gaylord Morley,	M	43	*Saginaw.*
George Randolph Morrison,		8	*Oak Park, Ill.*
William Clyde Mundt,	C	121	*Olean, N. Y.*
Charles Eugene Murdock,	S	30	*Saint Johns.*
James Joseph Murphy,			*Detroit.*
John Russell Murray,		6	*Owosso.*
John Harris Mustard,	E	111	*Scottville.*
Leonard Calvin Myers,		30	*Alpena.*
Juske Nagamatsu, *Hogakuin College,*			*Fukuoka Ken, Jap*
John Nils Nagle,		18	*Washington, D.*
Forrest Nagler,	M	38	*Middleville.*
Adrian John Neerken,	E	64	*Holland.*
Levi Heinrich Neilsen,		6	*Greenville.*
Alvin Holthe Nelson,	M	64	*Muskegon.*

es Walter Nelson,	M	71	*Bay City.*
Martin Nester,	C	34	*Lake Linden.*
ce Percy Nichols,	S	39	*Bay City.*
mer Cooley Nichols.	C	70	*Hastings.*
Michael Nisin,			*Union Grove, Wis*
Stephenson Norcross,	C	42	*Menominee.*
t Dewitt Norris,		3	*Troy, O.*
m Boydston North, M.D., *oledo Medical College,*	Ch	57	*Toledo, O.*
e Robinson Norton,	E	28	*Friendship, N. Y.*
e Oakes,		6	*Grand Haven.*
ner O'Brien,	M	25	*Detroit.*
m Wallace Odell,		13	*Chicago, Ill.*
an John Oldach,		6	*North East, Pa.*
Gustavus Olson,			*Chicago, Ill.*
y Emanuel Olson,	Ch	68	*Grand Rapids.*
Edward Olson,	C	109	*Ironwood.*
mar Scott Ortman,		6	*Detroit.*
ce Nehemiah Osburn,			*Detroit.*
P. Otte,			*Grand Rapids.*
rd Ottomann, Jr.,		6	*South Haven.*
Keehn Ovitz,	Ch	67	*Mineral Point, Wis*
Charles Padberg,			*Detroit.*
Alfred Paddock,	C	77	*Pontiac.*
James Palmer,			*Greenville.*
Austin Palmer,	C	34	*Geneva, N. Y.*
ric Edwin Park,	Ch	43	*Adrian.*
e Irwin Parker,	C	36	*Washington, D. C.*
mond Drake Parker,	E	80	*Detroit.*
Archibald Parks,	M	70	*Elk Rapids.*
William Parry,			*Ann Arbor.*
r Gray Pashby,	E	32	*Constantine.*
Lanphier Patton,			*Springfield, Ill.*
m Lear Pearson,	C	68	*Galesburg.*
rd Graeme Peattie,	C	32	*Chicago, Ill.*
es Franklin Peck,	C	72	*Allegan.*
e Roy Pendell,	M	33	*Saginaw.*
rd Foote Perkins,	E	70	*Grand Rapids.*
op Perkins,	E	13	*Ottawa, Ill.*
m James Perkins,		14	*Norway.*
es Holowill Perrin, Jr.,		3	*Moline, Ill.*
McKenzie Perrin,		6	*Detroit.*
Eugene Perrine,			*Jackson.*
r Babcock Perry,	M	108	*Ann Arbor.*
y Van Alstyne Pettit,	E	37	*Ottawa, Ill.*
Harvey Phinney,			*Detroit.*
e Owen Pinch,	E	49	*Battle Creek.*
lfred Plumb,	Ch	37	*Fenton.*

Stanley George Porter,		6	*Jackson.*
Frank James Post,		6	*Owosso.*
William Edward Post,	Mar	113	*Mansfield, O.*
Clark Zephaniah Potter,	Ch	23	*Jackson.*
Rossiter Raymond Potter,		6	*Kalamazoo.*
Arthur Edward Powell,			*Marquette.*
James Cooley Powell,			*Washington, D. C.*
Whitney Matthews Prall,	M	38	*Pontiac.*
Jesse Towsley Pratt,	M	114	*Bay City.*
Joseph Major Pratt,	M	40	*LaGrange, Ill.*
Arthur Gale Preston,		6	*Saint Joseph.*
John Davidson Price,	C	38	*Detroit.*
Gustav Edward Priess,		16	*Saginaw.*
Harris Phelps Ralston, A.B.,	Ch	129	*Caro.*
Horace Patton Ramey,		26	*Carlisle, Ky.*
Birtram Willard Ransom,	C	114	*Ann Arbor.*
George Alexander Ray,		8	*Mason City, Ia.*
Herbert Dwight Raymond,			*Traverse City.*
Arthur Mason Rebstock,	Mar	66	*Buffalo, N. Y.*
Forest Don Redden,			*Rossville, Ill.*
Russell Shattuck Reed,	Mar	55	*Chicago, Ill.*
Walter Christian Reibling,	Ch	73	*Detroit.*
Lon Grenard Reid,	E	34	*Akron, O.*
William Hume Reid,	M	38	*Bay City.*
Herbert Charles Remer,		6	*Saginaw, W. S.*
James William Rice,		8	*Dayton, O.*
Louis Nelson Rice,	M	79	*Detroit.*
Wilder Meloy Rich,			*Grand Rapids.*
Rex Densmore Richardson,	C	63	*Hastings.*
Glenn Armour Ricks,			*Taylorville, Ill.*
William Herman Riecks,		9	*Alpena.*
Maynard Hugh Riley,		6	*Ionia.*
Frank Arney Ritchie,			*Three Rivers.*
William Joseph Ritzel,			*Owosso.*
Leslie Delosse Robbins,	C	43	*Jones.*
†Charles Adolph Robertson,		15	*Muscatine, Ia.*
James Alexander Robertson,			*Escanaba.*
Elbert James Robinson,			*Fredonia, N. Y.*
Glenn Lyle Robinson,		6	*Birmingham.*
Kenneth Sargent Robinson,	C	52	*Ann Arbor.*
Lewis Chubb Rogers,	M	128	*Grand Rapids.*
George Wade Ross,	C	28	*Fostoria, O.*
Harry Alfred Rossman,	E	29	*Winchester, Ind.*
Robert Burton Rouse,		6	*Bay City.*
Vernon Webster Royce,		6	*Corunna.*
Lawrence Roys,	M	45	*Saginaw.*
Mason Pittman Rumney,		9	*Kalamazoo.*
Sidney Rumney Russel,	M	122	*Detroit.*

rd Ryan,	C	67	*Sault Ste. Marie.*
zer Brown Sadler,			*Sandusky, O.*
ard Hubbard Salmon,	M	35	*Syracuse, N. Y.*
Thomas Sample,	C	39	*Saginaw.*
Louis Sampson,			*Niles.*
das Scranton Sanford,		6	*Grand Rapids.*
Ashton Saunders,		6	*Cadillac.*
eth Ingalls Sawyer,		6	*Menominee.*
Matthias Scharlé,	C	38	*Chicago, Ill.*
r William Schlesinger,		6	*Detroit.*
rd Schneck,	Mar	72	*Detroit.*
n Richtig Schober,	C	69	*Iron Mountain.*
m Frederick Schregardus,	E	18	*Prairie City, Ia.*
Barnes Scott,	Ch	62	*Sterling, Ill.*
William Seens,	C	114	*Grand Rapids.*
Elliott Sevison,	C	38	*Constantine.*
m Seymour,	Ch	104	*Marshall.*
d Casewell Sharpe,		6	*Grand Rapids.*
Thomas Shaw,			*Elm.*
Andrew Sherman,		36	*Owosso.*
Collin Shoecraft,	M	70	*Coldwater.*
Gifford Sibley,	M	16	*Detroit.*
elivan Sidener,	C	32	*Sturgis.*
ond Byron Silverman,	Ch	34	*Detroit.*
L. Simpson,			*Freeport.*
n Skidmore,		6	*Fenton.*
e Duffield Slaymaker,	M	39	*Detroit.*
nce Henry Sleight,	C	58	*Ann Arbor.*
Richard Sloane, Jr.,		14	*Sandusky, O.*
rd Alonzo Small, Jr.,			*Highland Park, Ill.*
ice David Smilansky,	E	36	*Detroit.*
Hamlin Smith,	C	104	*Lansing.*
ld David Smith,	C	112	*Hastings.*
e Hill Smith,	M	33	*Bay City.*
d Craig Smith.		6	*Detroit.*
n Howard Smith,		25	*Lamoille, Ill.*
Finlay Smith,	M	92	*Detroit.*
Francis Smith,	C	43	*Mosherville.*
John Smith,	Ch	70	*Manistee.*
r Charles Smith,	E	76	*Detroit.*
h James Smith,	E	36	*Saginaw.*
Edward Snow, Jr.,	M	25	*Detroit.*
m Edward Snushall,	E	81	*Traverse City.*
r Harmon Sparr,	C	59	*Benton Harbor.*
as Hamilton Spaulding,	E	13	*Charlotte.*
r D. Spencer,	E	32	*Ann Arbor.*
ns Edward Speyer,		4	*Kalamazoo.*
Spofford, Jr.,	M	25	*North East, Pa.*

Sherwood Hubbard Standish,	M	75	*Detroit.*
Rex Cameron Starr,		6	*Coldwater.*
Richard Mallery Stearns,	M	17	*Elgin, Ill.*
Dee James Sterrett,	C	75	*Cherry Creek, N.Y.*
Earl Hugh Stewart,	E	39	*Big Rapids.*
Raymond Griffiths Stewart,	M	34	*Bay City.*
Erna Cary Stiles,		6	*Wyandotte.*
Morris Henry Stimson,	M	109	*Grand Rapids.*
Walter Pearce Stine,	C	103	*Manistee.*
Ernest Gustav Stock,		5	*Sioux City, Ia.*
George Oliver Stoffer,	E	60	*Williamston.*
James Stokoe,	M	56	*Ishpeming.*
Ralph Albert Stow,	E	70	*Grand Rapids.*
Harry Straub,	E	37	*Dowagiac.*
Iro Cleveland Stricker,	M	51	*Three Rivers.*
George Gottlieb Stroebe, Ph.B., *University of Chicago,*	C	75	*Ferrysburg.*
William Yrot Stroh,	Ch	35	*Coldwater.*
Eugene Nathaniel Strom,	M	39	*Austin, Ill.*
Levi Wilton Strong,		6	*Amsterdam, N. Y.*
Vedder Strong,			*Amsterdam, N. Y.*
William Shackleford Sullivan,	C	61	*Ann Arbor.*
James Irving Sutherland,		6	*Detroit.*
Edgar Ossian Swanson,			*Elkhart, Ind.*
Charles Roscoe Swineford,	M	100	*Ann Arbor.*
Benjamin Rand Taber,		3	*Saginaw.*
Roscoe Lovejoy Taft,	M	19	*Ann Arbor.*
Thomas James Tervial Tait,			*Ann Arbor.*
Hugo Wetterlund Taleen,		9	*Ishpeming.*
Carl Edward Tannewitz,			*Grand Rapids.*
†David Taylor,			*Ann Arbor.*
Kenyon Yale Taylor,	C	44	*Kenilworth, Ill.*
Juan Felix Roura Tecson,	C	123	*Manila, P. I.*
Delmar Edson Teed,	C	71	*Cadillac.*
Robert Mortimer Teele,			*Grand Rapids.*
William Wolcott Tefft,	C	32	*Jackson.*
Fred Remington Temple,	E	67	*Detroit.*
Arthur Gustav William Templin,			*Detroit.*
George William Terry,		6	*South Haven.*
Ellis Wilby Test,	M	41	*LaPorte, Ind.*
George Garrett Thompson,	E	103	*Plainwell.*
James Walter Thompson,		22	*Grand Rapids.*
Robert Richardson Thomson,	M	112	*Ann Arbor.*
Isaac Jay Thorp,		40	*Toledo, O.*
Henry Hoag Tibbs,	C	31	*Grand Rapids.*
Ralph Russell Tinkham,	C	75	*Ann Arbor.*
William Edward Tipping,		6	*National Mine.*
Martin Stambaugh Tod,		6	*Youngstown, O.*

Henry Mathews Towar,	M	23	*Detroit.*
Reginald Heber Towler,	C	81	*Detroit.*
Neil Sherman Townsend,		6	*Ionia.*
Ray Elnathan Townsend,			*Leonard.*
Fred Hall Tracy,		8	*Grand Rapids.*
Warren Willits Tracy,	M	70	*Three Rivers.*
Alfred Alanson Treadway,		6	*Grand Rapids.*
Byram Clarkson Trueblood,	Ch	37	*Ann Arbor.*
Carmi Jefferson Tryon, Jr.,	Ch	70	*Akron, O.*
Fred Henry Tuck,	M	33	*Belding.*
George Edwin Tucker,	M	80	*Monson, Mass.*
Hubert Southwick Tullock,	C	19	*Leavenworth, Kan.*
Mahlon Cleveland Tunison,		6	*Fenton.*
John Sherrerd Tyler,	M	116	*York, Pa.*
Charles John Ullrich,	C	44	*Michigan City, Ind.*
Frank Felker Ulrich,		6	*Grand Rapids.*
Carl Herbert Upmeyer,	C	94	*Fort Wayne, Ind.*
Jay DeWitt Utley, Jr.,	M	39	*Grand Rapids.*
Ralph Aaron Vail;	M	109	*LaPorte, Ind.*
William Steel Vail,			*San Jacinto, Cal.*
Carl Louis Vandeman,	M	73	*Denver, Col.*
Henry Philip Tappan Van Keuren,	Mar	31	*Howell.*
Theodore Casimir Emil van Manen,		21	*The Hague, Holland*
John Marcus Van Splunter,	E	112	*Grand Rapids.*
Charles Craigie Van Valkenburgh, Jr.,	C	55	*Fresno, Cal.*
Clark Van Vlerah,		6	*Mason.*
Frank Vaughn,	C	61	*Otsego.*
Alberto Villa,	S	30	*Mexico City, Mex.*
Eugenio Villa, A.B., *School of Mines, Mexico City,*	C	61	*Mexico City, Mex.*
Oswald William Visscher, A.B., *Hope College,* A.B.,	E	160	*Holland.*
Nelson Joshua Vliet,	E	39	*Detroit.*
Karl Eugene Vogel,	C	64	*Chelsea.*
Joseph Vernor Voorheis,	C	121	*Detroit.*
Oswald Martin Wagenseil,			*Port Huron.*
Carl Sweetland Wagner,			*Ann Arbor.*
Frederick George Wahl,	Ch	70	*Coldwater.*
Donald Cramer Waite,	C	109	*Yonkers, N. Y.*
John Roby Waldo,		6	*Detroit.*
William Thomas Walker, Jr.,	M	128	*Toledo, O.*
Erwin Van Doren Wallace,		3	*Oswego, N. Y.*
John Frederick Wallack, Jr.,		6	*Chicago, Ill.*
Thomas Robert Walter,		5	*Kalamazoo.*
Otto Christian Walther,	E	105	*Saginaw.*

Edward Northam Walton,	**M**	104	*Plainwell.*
Harry Collins Walton,		6	*Plainwell.*
William James Fairbairn Ward,	C	38	*Detroit.*
Elmer Edwin Ware,	Ch	115	*Auburn, N. Y.*
Charles Albert Waring,	M	100	*Tecumseh.*
Eugene Taylor Warner,		6	*Flint.*
Leon Albert Warren,			*Edmore.*
Henry G. Watson,	C	68	*Muskegon.*
Jay Rogers Watson,	E	34	*Saline.*
Hal C. Weaver,		12	*Charlotte.*
Don Byron Webster,	M	75	*Ann Arbor.*
Harold Julian Weeks,		6	*Allegan.*
Edward August Weiland,	**M**	131	*Toledo, O.*
Richard Arod Welch,	**E**	71	*Davisburg.*
Roswell Murray Wendell,		6	*Detroit.*
Kirke Gaylord Westfall,		6	*Chesaning.*
Cleon DeMont Wheeler,		2	*Three Rivers.*
Harold Sayre Wheeler,	M	31	*Manistee.*
Maurice Walter Wheeler,	C	69	*Detroit.*
Charles John Whipple,		21	*Chicago, Ill.*
Lewey James Whitcomb,		30	*Vassar.*
Daniel Asaph White,	C	80	*Otsego.*
George James White,	Ch	32	*Pontiac.*
Henry Berry White,		6	*Friendship, N. Y.*
John Arnon Whiting,	C	109	*Philadelphia, N. Y.*
Laurence Chauncey Whitlark,	M	80	*Ann Arbor.*
Harry Gill Whitman,	Ch	34	*Grand Rapids.*
James Dale Whitmore,	M	70	*Toledo, O.*
Lewis Eugene Whitney,			*Grand Rapids.*
Lawrence Charles Whitsit,		6	*Ann Arbor.*
Lyle Antrim Whitsit,	C	116	*Ann Arbor.*
Ralph Benjamin Wiley,	C	34	*Detroit.*
Dean Bailey Wilhelm,	M	39	*Ann Arbor.*
Elmer Williams,	C	49	*Detroit.*
Glenn Byron Williams,		6	*Plainwell.*
Theodore Clark Williams,			*Ann Arbor.*
Warren Benjamin Williams,			*Hastings.*
Joe Willis,	M	52	*Chicago, Ill.*
Walter Irving Willis,	E	30	*Buffalo, N. Y.*
Carlos Arthur Williston,	C	98	*Bay City.*
Harold Fraser Williston,	C	28	*Jackson.*
Clyde Elmore Wilson,	M	54	*Ann Arbor.*
Samuel Wilson,	C	69	*Anderson.*
William Kissick Wilson,	E	66	*Ypsilanti.*
Harold Douglas Wines,		6	*Ann Arbor.*
William Michael Winkler,		12	*Saginaw.*
Clarence Wise,			*Otsego.*
Chester Owen Wisler,			*Detroit.*

Marion Saling Wolfe,		8	*Chicago, Ill.*
Vernon Claude Wood,	Mar	112	*Detroit.*
Fred Leroy Woods, A.B.,			*Cassopolis.*
John Joseph Woolfenden,	E	77	*Detroit.*
Joseph William Wooley, Jr.,		5	*Youngstown, O.*
Rew Edward Woolley,	E	34	*Ann Arbor.*
Harry Albert Workman,			*Chicago, Ill.*
Jesse Clark Wright,	C	113	*Holly.*
John Harvey Wyman,			*Ann Arbor.*
Philip Warner Yallowick,	C	39	*Buffalo, N. Y.*
Arton Emory Yokom,	C	107	*Gladstone.*
Arrigo Young,	M	50	*Chicago, Ill.*
†James Herbert Young	Mar	83	*Urbana, Ill.*
Charles Christian Zabriskie,		6	*Detroit.*
Charles Albert Zagelmeier,		6	*Hastings.*
Philip Adolph Zang,		16	*Denver, Col.*
Otto S. Zelner,	C	75	*Lake Odessa.*
Oscar Waltermer Zelt,		6	*Sturgis.*
William Emil Zietlow,		15	*Filer City.*
Lee Danforth Zimmerman,	C	31	*Wayne.*

131. SUMMARY OF STUDENTS

Resident Graduates	2
Graduates Studying *in absentia*	10
Undergraduates	816
	828

	First Year Students	Second Year Students	Third Year Students	Fourth Year Students	Graduate Students	Totals
Civil Engineering	First year students being required to pursue the same order of studies, are not classified.	57	55	38	4	154
Mechanical Engineering		75	45	42	5	167
Electrical Engineering		52	28	20	3	103
Chemical Engineering		18	15	8	....	41
Marine Engineering		6	3	3	....	12
Specials		15	3	2	....	20
Totals	333	223	149	113	12	830
Deduct for names counted twice						2
Total						828

Officers of the Alumni Association

President	Victor H. Lane	'74 *e*, '78 *l*	*Ann Arbor*
Vice-President	Loyal E. Knappen	'73	*Grand Rapids*
Recorder	Louis P. Jocelyn	'87	*Ann Arbor*
Treasurer	G. Carl Huber	'87 *m*	*Ann Arbor*
General Secretary	Shirley W. Smith	'97	*Ann Arbor*

Board of Directors

	TERM EXPIRES
G. Carl Huber	1904
Victor H. Lane	1905
Louis P. Jocelyn	1906
Loyal E. Knappen	1907
Fred Newton Scott	1908

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1st sem

UNIVERSITY OF MICHIGAN

DEPARTMENT OF ENGINEERING

FIRST SEMESTER, 1904-5

DIRECTIONS FOR REGISTRATION AND CLASSIFICATION

Entrance. Students entering the Department of Engineering for the first time should present themselves, with their credentials, to the Associate Dean in his office in Room 6 of the *old* Engineering building for admission to the department. After having been admitted and having paid their fees, they should report for assignment to classes in Room 409 on the top floor of the *new* Engineering building at the following times, according to the numbers on their admission certificates. Treasurer's receipt must be presented at this time. Students who desire advanced credit should bring with them at that time their credentials and all drawings made by them if they desire credit in that subject:

Nos. 1676 to 1700, Saturday, Sept. 24, at 8 A. M.
Nos. 1701 to 1735, Saturday, Sept. 24, at 10 A. M.
Nos. 1736 to 1770, Saturday, Sept. 24, at 2 P. M.
Nos. 1771 to 1800, Saturday, Sept. 24, at 4 P. M.
Nos. 1801 to 1835, Monday, Sept. 26, at 8 A. M.
Nos. 1836 to 1870, Monday, Sept. 26, at 10 A. M.

Nos. 1871 to 1905, Monday, Sept. 26, at 2 P. M.
Nos. 1906 to 1940, Monday, Sept. 26, at 4 P. M.
Nos. 1941 to 1975, Tuesday, Sept. 27, at 8 A. M.
Nos. 1976 to 2010, Tuesday, Sept. 27, at 10 A. M.
Nos. 2011 to 2045, Tuesday, Sept. 27, at 2 P. M.
Nos. 2046 to 2076, Tuesday, Sept. 27, at 4 P. M.

Students *re-entering* the department after having withdrawn should present themselves to the Secretary for re-enrollment.

Advanced Credits. Students desiring advanced credits beyond the eight hours which may be given by the Associate Dean for modern language work, should apply to the Associate Dean at the time of admission for a blank upon which the subjects in which credit is desired will be checked. This blank should then be taken to the proper teachers, at the times and places indicated below.

Classification. *Treasurer's receipt must be presented at time of classification.*

All students entering upon their *second year's work*, whether candidates for a degree or special students, should report in Room 309, new Engineering building, for classification.

Students commencing their *third* or *fourth year's work* should report for classification as follows:

Civil Engineers, Professor Williams and Assistant Professor Greene, Room 205.

Mechanical Engineers, Professor Allen, Room 217.

Electrical Engineers, Professor Patterson, Room 201.

Chemical Engineers, Professor Campbell, Chemical Laboratory.

Marine Engineers, Professor Sadler, Room 327.

Special Students in their third or fourth years of residence should report with the regular students of the most closely allied course.

Students who have removed conditions on the days immediately preceding the opening of college should obtain from the Secretary a certificate to that effect, and present it when reporting for classification.

OFFICE HOURS AND ROOMS

For the week commencing Saturday, Sept. 24.

Dean—Professor Cooley. Office hours for students, 11-12. Room 213.

Associate Dean—Professor Davis. 9-12 and 2-5, beginning Sept. 19. Room 6.

Secretary—Assistant Professor Goulding. Same as Classification Committee. The Secretary's office will be open daily from 8-12 and 1 :30-5.

Classification Committee—For rooms see under *Classification.*)

Saturday, 1st and 2d year students, 8-12 and 2-6.
Saturday, 3d and 4th year students, 9-11 and 2-4.
Monday, all classes, 8-12 and 2-6.
Tuesday, all classes, 8-12 and 2-6.

On Tuesday evening classification will be continued at half-past seven, until all students who received numbers before five o'clock have had an opportunity to be classified.

Wednesday	4-5 P. M.
Thursday	
Friday	

Saturday, 9-10 A. M.

Advanced Credits. Except when otherwise stated, the hours will be as follows:

Saturday, Monday and Tuesday, 9-11 and 2-4.
Wednesday, Thursday and Friday, 4-5.
Saturday, 9-10.

English	Mr. Abbott. Room 317.
French, German, and Spanish	Assistant Professor Wait. Room 428.
Mathematics	Professor Ziwet. Room 312.
Physics	Professor Carhart Professor Reed Physical Laboratory
Chemistry 2	Mr. Smeaton. Room 317.
Chemistry, advanced Metallurgy	Professor Campbell. Chemical Laboratory.
Astronomy	Professor Hall. Room 22, U. (11-12 only).
Mineralogy	
Geology	Professor Russell. Room 6, top floor, Museum.
Drawing	Professor Denison. Room 414.
Shop Practice	Superintendent Miggett. Engineering Shops.
Surveying	Professor Davis. Room 301 (2-3 P. M. after Oct. 1 only).
Civil Engineering	Professor Williams. Room 205.
Mechanical Engineering	Professor Allen. Room 217.
Electrical Engineering	Professor Patterson. Room 201.
Naval Architecture and Marine Engineering	Professor Sadler. Room 327.

Commencement of Work. The work of the classes in the Engineering Department will begin on Wednesday, Sept. 28, and on and after that date all classes will meet at their regular hours.

SCHEDULE

ABBREVIATIONS: U.—University Hall. T. H.—Tappan Hall. Phys.—Physics Laboratory. Chem.—Chemical Laboratory.

Numbers below 100 not followed by letters indicate the old Engineering building.

Numbers above 100 indicate the new Engineering building.

ENGLISH

1. Paragraphing and Theme Writing. *Four hours.* Messrs. Abbott, Tarbox, and Fulton.

Sec. I,	T W Th S,	at 8,	Room 21.
Sec. II,	T W Th S,	at 8,	Room 23.
Sec. III,	M W F S,	at 10,	Room 21.
Sec. IV,	M W F S,	at 10,	Room 23.
Sec. V,	T W Th F,	at 2,	Room 21.
Sec. VI,	T W Th F,	at 2,	Room 23.
Sec. VII,	M W F S,	at 9,	Room 21.
Sec. VIII,	M W F S,	at 9,	Room 23.

1*a*. Theme Writing. *Two hours.*

Sec. I,	M W	at 11,	Room 21.
Sec. II,	T Th	at 1,	Room 21.
Sec. III,	W F	at 1,	Room 21.

2. (Elective.) Technical Journalism. *Two hours.* This course will be offered if desired by at least six students. Hours to be arranged. Mr. Abbott.

FRENCH

1. Elementary Course. *Four hours.*

Sec. I,	M T Th F,	at 8,	Room 28.	Mr. Adams
Sec. II,	M T Th F,	at 2,	Room 28.	Mr. Bird
Sec. III,	M T Th F,	at 4,	Room 28.	Mr. Adams

2. Elementary Course continued. *Four hours.* Will not be given this semester.

3. Reading of French Scientific Literature. *Four hours.*

Sec. I,	M T Th F,	at 8,	Room 10.	Mr. Bird.
Sec. II,	M T Th F,	at 10,	Room 10.	Mr. Peck.
Sec. III,	M T Th F,	at 2,	Room 10.	Mr. Adams
Sec. IV,	M T Th F,	at 3,	Room 10.	Mr. Peck.
Sec. V,	M T Th F,	at 4,	Room 10.	Mr. Bird.

4. Reading of French Scientific Literature continued. *Four hours.* Will not be given this semester.

5. (Elective.) Advanced Course in French Scientific Literature. *Three hours.* See below.

6. (Elective.) French Conversation. *Three hours.* See below.
7. (Elective.) Commercial and Journalistic Newspaper French. *Three hours.* See below.
8. (Elective.) Literary French. *Three hours.* See below.

Of Courses 5, 6, 7, 8 only one will be offered this semester. The course desired by the largest number of students (provided there are at least six) will be offered by Mr. Bird. Hours to be arranged.

GERMAN

1. Elementary Course. *Four hours.*

Sec. I, M T Th F, at 8, Room 1. Mr. Dubee.
Sec. II, M T Th F, at 10, Room 1. Mr. Dubee.
Sec. III, M T Th F, at 2, Room 1. Mr. Menger.
Sec. IV, M T Th F, at 3, Room 1. Mr. Menger.

2. Elementary Course continued. *Four hours.* Will not be given this semester.
3. Reading of German Scientific Literature. *Four hours.*

Sec. I, M T Th F, at 8, Room 32. Mr. Menger.
Sec. II, M T Th F, at 10, Room 26. Asst. Prof. Wait.
Sec. III, M T Th F, at 2, Room 24. Mr. Dubee.
Sec. IV, M T Th F, at 2, Room 28. Asst. Prof. Wait.
Sec. V, M T Th F at 3, Room 28. Asst. Prof. Wait.
Sec. VI, M T Th F at 4, Room 1. Mr. Menger.
Sec. VII, M T Th F, at 4, Room 21. Mr. Dubee.

4. Reading of German Scientific Literature continued. *Four hours.*

Sec. I, M T Th F, at 10, Room 32. Mr. ————.
Sec. II, M T Th F, at 3, Room 21. Mr. ————.

5. (Elective.) Advanced Course in German Scientific Literature. *Three hours.* See below.
6. (Elective.) German Conversation. *Three hours.* See below.
7. (Elective.) Commercial and Journalistic Newspaper German. *Three hours.* See below.
8. (Elective.) Literary German. *Three hours.* See below.

Of courses 5, 6, 7, 8 only one will be offered this semester. The course desired by the largest number of students (provided there are at least six) will be offered by Assistant Professor Wait, at 9. Room —.

SPANISH

1. Elementary Course. *Four hours.*
   Sec. I, M T Th F, at 1. Room 10. Mr. Bird.
2. Elementary Course continued. *Four hours.* Will not be given this semester.
3. Reading, Conversation and Business Correspondence. *Four hours.* Hours to be arranged. Mr. Adams.
   This course will be offered only if desired by six or more students.

MATHEMATICS

1. Algebra and Analytic Geometry. *Four hours.*

Sec. I,		T	W	Th	F,		at 8,	Room 31.	Mr. Butts.
Sec. II,		T	W	Th	F,		at 8,	Room 24.	Mr. Escott.
Sec. III,		T	W	Th	F,		at 8,	Room 28.	Dr. Karpinski.
Sec. IV,		T	W	Th	F,		at 8,	Room 6.	Dr. Field.
Sec. V,		T	W	Th		S,	at 9,	Room 6.	Dr. Field.
Sec. VI,		T	W	Th		S,	at 9,	Room 1.	Mr. Bradshaw.
Sec. VII,	M		W		F	S,	at 9,	Room 28.	Dr. Karpinski.
Sec. VIII,	M		W		F	S,	at 9,	Room 24.	Mr. Escott.
Sec. IX,		T	W	Th	F,		at 10,	Room 28.	Dr. Karpinski.
Sec. X,		T	W	Th	F,		at 10,	Room 6.	Dr. Field.
Sec. XI,		T	W	Th	F,		at 10,	Room 31.	Mr. Bradshaw.
Sec. XIII,	M	T		Th	F,		at 11,	Room 32.	Dr. Running.
Sec. XIV,	M	T		Th	F,		at 11,	Room 28.	Dr. Karpinski.
Sec. XV,		T	W	Th	F,		at 11,	Room 1.	Mr. Bradshaw.

1*a*. Plane Trigonometry. *Two hours.*

Sec. I,	M				S,	at 8,	Room 6.	Dr. Pierce.
Sec. II,	M				S.	at 8,	Room 31.	Mr. Butts.
Sec. III,	M				S,	at 8,	Room 28.	Dr. Karpinski.
Sec. IV,		T		Th,		at 2,	Room 31.	Dr. Pierce.
Sec. V,		T		Th,		at 2,	Room 205.	Mr. Marshall.
Sec. VI,		T		Th,		at 3,	Room 24.	Mr. Bradshaw.
Sec. VII,		T		Th,		at 3,	Room 31.	Dr. Running.

3. Calculus. *Five hours.*

Sec. I,	M	T	W	Th	F,	at 8,	Room 313.	Professor Ziwet.
Sec. II,	M	T	W	Th	F,	at 8,	Room H, U.	Prof. Markley.
Sec. III,	M	T	W	Th	F,	at 8,	Room 19, U.	Asst. Prof. Glover.
Sec. IV,	M	T	W	Th	F,	at 9,	Room 31.	Mr. Butts.
Sec. V,	M	T	W	Th	F,	at 9,	Room 1, T. H.	Mr. Marshall.
Sec. VI,	M	T	W	Th	F,	at 9,	Room 32.	Dr. Running.
Sec. VII,	M	T	W	Th	F,	at 10,	Room 24.	Mr. Escott.
Sec. VIII,	M	T	W	Th	F,	at 10,	Room 201.	Dr. Pierce.
Sec. IX,	M	T	W	Th	F,	at 11,	Room 201.	Dr. Pierce.
Sec. X,	M	T	W	Th	F,	at 11,	Room 24.	Dr. Field.

5. Calculus and Mechanics II. *Three hours.*

Sec. I,	M	W	F,	at 9,	Room 19, U.	Asst. Prof. Glover.
Sec. II,	M	W	F,	at 9,	Room 219.	Dr. Pierce.
Sec. III,	M	W	F,	at 10,	Room 313.	Professor Ziwet.
Sec. IV,	M	W	F,	at 11,	Room 31.	Mr. Butts.
Sec. V,	M	W	F,	at 1,	Room 205.	Mr. Marshall.
Sec. VI,	M	W	F,	at 2,	Room 201.	Dr. Running.
Sec. VII,	M	W	F,	at 2,	Room 205.	Mr. Marshall.

PHYSICS

2. Heat, Electricity, and Magnetism. *Five hours.*

Lectures—

Sec. I,	M	W	F,	at 9,	Phys. Lec. Room.	Dr. Randall.
Sec. II,	M	W	F,	at 11,	Phys. Lec. Room.	Prof. Carhart.

Quizzes—

Sec. I,	T	Th,	at 8,	Room 20, Phys.
Sec. II,	T	Th,	at 8,	Room 217.
Sec. III,	T	Th,	at 8,	Room 219.
Sec. IV,	T	Th,	at 9,	Room 20, Phys.
Sec. V,	T	Th,	at 9,	Room 24.
Sec. VI,	T	Th,	at 9,	Room 21.
Sec. VII,	T	Th,	at 10,	Room 20, Phys.
Sec. VIII,	T	Th,	at 10,	Room 21.
Sec. IX,	T	Th,	at 11,	Room 20, Phys.
Sec. X,	T	Th,	at 11,	Room 21.
Sec. XI,	T	Th,	at 11,	Room 31.

3*b*. Physical Laboratory Work. *Two hours.*

Sec. I,	M			from 1-5, Lab. A, Phys.
Sec. II,		W		from 1-5, Lab. A, Phys.
Sec. III,			F	from 1-5, Lab. A, Phys.

3*c*. Laboratory Work in Mechanical and Electrical Measurements. *Three hours.*

Sec. I,	M				F		from 9-12, Lab. A, Phys.
Sec. II,			W			S	from 9-12, Lab. A, Phys.
Sec. III,		T		Th			from 2-5, Lab. A, Phys.

7. (Elective.) Mathematical Electricity and Magnetism. *Three hours.* Must be preceded by Course 2, and requires a knowledge of Calculus. Hours to be arranged. Professor Carhart.

8. (Elective.) Heat. Laboratory Work. *Two hours.* Must be preceded by Course 2. Hours to be arranged. Dr. Randall.

9. (Elective.) Theory of Heat. *Two hours.* Hours to be arranged. Professor Carhart.

CHEMISTRY

1. Elementary Inorganic Chemistry. (For entrance.) *Two hours.*

Lectures M and F, at 11, Lower Lecture Room, Old Medical Building.

Quiz W at 11, in Room —. Professor Bigelow.

2. Principles of Inorganic Chemistry. (Formerly Course A.) *Four hours.*

Lectures W at 11 and S at 9. Lower Lecture Room Old Medical Building. Mr. Smeaton and Mr. ———.

Quizzes—

Sec. I,	M		Th,		at 9, Room C, Chem.
Sec. II,	M		Th,		at 9, Room 10.
Sec. III,		T		F,	at 9, Room C, Chem.
Sec. IV,		T		F,	at 9, Room 10.
Sec. V,	M		Th,		at 11, Room A, Chem.
Sec. VI,	M		Th,		at 11, Room 10.
Sec. VII,		T		F,	at 11, Room A, Chem.
Sec. VIII,		T		F,	at 11, Room C, Chem.

3. Qualitative Analysis. (Formerly Course B.) *Seven hours.* Professor Johnson and Mr. Willard.
Sec. I, M W F, at 8, Room B, Chem.
Sec. II, M W F, at 9, Room B, Chem.
Hours of laboratory work to be arranged.

5. Quantitative Analysis. (Formerly Course C). Beginning course. *Five hours.*
T Th. at 10, Room B, Chem. Professor Campbell.
Hours of laboratory work to be arranged.

7. Organic Chemistry. (Formerly Course E.) *Five hours.*
M T W Th F, at 9. Room A, Chem. Professor Gomberg.

28. Advanced Quantitative Analysis. Laboratory work (Formerly Course D.) *Five hours.* Professor Campbell.

29. (Elective.) Iron and Steel Analysis. Laboratory work. (Formerly Course G.) *Five hours.* Professor Campbell.

31. (Elective.) Independent Work in Mineral Analysis. Laboratory work. (Formerly Course H.) *Five hours.* Professor Campbell.

32. (Elective.) Assaying. Laboratory work. (Formerly Course K.) *Two hours.* Assistant Professor White.
Sec. I, M W from 1-4.
Sec. II, T Th from 1-4.

33. Chemical Technology. (Formerly Course L.) *Five hours.*
M T W Th F, at 11, Room B, Chem. Asst. Prof. White.

35. Gas Analysis. Laboratory work. (Formerly Course I.) *Two hours.* Assistant Professor White.
Sec. I, M W from 1-4.
Sec. II, T Th from 1-4.

39. Chemical Technology. Laboratory work. (Formerly Course N.) *Five hours.* Professor Campbell and Assistant Professor White.

42. (Elective.) Organic Synthesis. Laboratory work. (Formerly Course F.) *Three, four or five hours.* Professor Gomberg.

METALLURGY

1. Fuel, Refractory Material, Iron and Steel.
M W F, at 9, Room 309. Professor Campbell.

2. (Elective.) Descriptive study of influence of heat and mechanical treatment upon metals and alloys. *One hour.* Must be preceded by Course 1. Mr. Smeaton.
3. (Elective.) Micrometallography. Laboratory work. *One hour.* Must be preceded or accompanied by Course 2.

ASTRONOMY

4. Practical Astronomy. *Three hours.*
Recitations M W F, at 8, after Dec. 1. Room 22, U. Practice at observatory three nights a week until December. Professor Hall.
5. (Elective.) Spherical Astronomy. *Three hours.*
M W F, at 11. Room 22, U. Professor Hall.
Must be preceded by Course 4.
13. (Elective.) Theory of Least Squares. *Two hours.*
M F, at 9. Room 22, U. Professor Hall.

MINERALOGY

1. Lectures and practice. *Two hours.*
Sec. I, T Th, at 9. Room —. Mr. ———.
Sec. II, T Th, at 11. Room —. Mr. ———.

GEOLOGY

1. (Elective.) Elements of Geology. *Three hours.*
M W F, at 3. Museum Lecture Room. Professor Russell.

DRAWING

1. Geometrical Drawing. *Four hours.*

Sec. I,	M T Th F,	from 10-12.	Room 415.	Mr. Wilson.
Sec. II,	M T Th F,	from 10-12.	Room 415.	Mr. Stroebe.
Sec. III,	M T Th F,	from 10-12.	Room 418.	Mr. Bartlett.
Sec. IV,	M T Th F,	from 10-12.	Room 418.	Mr. ———.
Sec. V,	M T Th F,	from 8-10,	Room 415.	Mr. Goulding.
Sec. VI,	M T Th F,	from 8-10.	Room 418.	Mr. ———.
Sec. VII,	M T Th F,	from 8-10.	Room 415.	Mr. Stroebe.
Sec. VIII,	M T Th F,	from 2-4.	Room 418.	Mr. Bartlett.

4. Free-Hand Drawing. *Three hours.*
Sec. I. M W F, from 8-10. Room 403. Mr. Bartlett.

*Sec. II,	M W F,	from 8-10.	Room 35.	Miss Hunt.
Sec. III,	M W F,	from 10-12.	Room 403.	Prof. Denison.
*Sec. IV,	M W F,	from 10-12.	Room 35.	Miss Hunt.
Sec. V,	M W F,	from 1-3.	Room 403.	Mr. Stroebe.
Sec. VI,	M W F,	from 1-3.	Room 35.	———.

10. (Elective.) Architectural and Water-Color Drawing, Advanced. *Two hours.*

T Th, from 10-12. Room 35. Professor Denison and Miss Hunt.

Must be preceded by Course 8.

13. (Elective.) Water-Color Drawing. *Three hours.* Hours to be arranged. Professor Denison and Miss Hunt.

Must be preceded by Course 8.

SHOP PRACTICE

1. Carpentry and Blacksmithing. *Four hours.*

Sec. I,	M F,	from 7:30-12.	Mr. Purfield. Mr. McDonald.
Sec. II,	T Th,	from 7:30-12.	
Sec. III,	W S,	from 7:30-12.	
Sec. IV,	M F,	from 1-5:30.	

1*b*. Pattern Making. *Two hours.*

This course will be given also in the second semester of this year, but thereafter will be consolidated with Course 3*a* as a *four hour* course.

Sec. I,	M,	from 1-5:30.	Mr. Purfield.
Sec. II,	T,	from 1-5:30.	Mr. Purfield.
Sec. III,	W,	from 1-5:30.	Mr. Purfield.
Sec. IV,	Th,	from 1-5:30.	Mr. Purfield.
Sec. V,	F,	from 1-5:30.	Mr. Purfield.
Sec. VI,	S,	from 7:30-12.	Mr. Purfield.

3*a*. Foundry Work. *Two hours.*

This course will also be given in the second semester of this year, but thereafter will be consolidated with Course 1*b* as a *four hour* course.

Sec. I, S, from 7:30-12. Mr. Winslow.

Other sections will be arranged if necessary.

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*Secs. II and IV are primarily for literary students.

3. Machine Shop. (Old 4*a* and 4*b*.) *Four hours.*

Sec. I,	M W,	from 7:30-12.	Mr. Cobb.
Sec. II,	M W,	from 1-5:30.	Mr. Cobb.
Sec. III,	T Th,	from 1-5:30.	Mr. Cobb.

4*b*. Advanced Machine. *Two hours.*

Sec. I,	Th,	from 7:30-12.	Mr. Cobb.
Sec. II,	F,	from 7:30-12.	Mr. Cobb.
Sec. III,	F,	from 1-5:30.	Mr. Cobb.

SURVEYING

1. Lectures, Text-book and Field Practice. *Five hours.*
   M T W Th F, from 1-5. Rooms 301-304. Professor Davis and Mr. Merrick.
4. Use of Instruments. *One hour.*
   Hours to be arranged. Rooms 301-304. Professor Davis and Mr. Merrick.

CIVIL ENGINEERING

1. Municipal Engineering. This course will not be given this semester, but will be given in the second semester as Water Supply Engineering. *Five hours.* Professor Williams.

3. Graphical Analysis of Structures. *Two hours.*

Sec. I,	T Th,	at 8.	Room 205.	Professor Williams.
Sec. II,	T Th,	at 9.	Room 203.	Asst. Prof. Greene.
Sec. III,	M W,	at 8.	Room 402.	Mr. Wilson.
Sec. IV,	T Th,	at 10.	Room 203.	Asst. Prof. Wrentmore
Sec. V,	M W,	at 10.	Room 203.	Asst. Prof. Greene.

4. Graphical Analysis of Structures, Advanced. *Two hours.*

Sec. I,	M W,	at 9.	Room 205.	Asst. Prof. Wrentmore
Sec. II,	M F,	at 11.	Room 205.	Asst. Prof. Wrentmore

6. Theory of Construction. *Two hours.*

Sec. I,	T F,	at 9.	Room 205.	Professor Williams
Sec. II,	T F,	at 10.	Room 203.	Asst. Prof. Greene

7. Engineering Design. *Five hours.*
   M T W Th F, from 1-4. Room 302. Assistant Professors Greene and Wrentmore.

9. Hydraulics. *One hour.*

Sec. I,	F,	at 8.	Room 205.	Professor Williams
Sec. II,	Th,	at 10.	Room 205.	Professor Williams
Sec. III,	Th,	at 9.	Room 205.	Professor Williams

11. Engineering Design, Advanced. *Five hours.* Hours to be arranged. Professors Williams, Greene and Wrentmore.

12. Water Supply and Sewerage will not be given.

15. Municipal Engineering. *Two hours.*
M W, at 10. Room 205. Professor Williams.

MECHANICAL ENGINEERING

1. Elements of Machines. Nomenclature. *Two hours.* Mr. Bursley and Mr. ———.

Sec. I,	T Th,	at 11.	Room 310.
Sec. II,	W F,	at 10.	Room 310.
Sec. III,	W F,	at 9.	Room 310.
Sec. IV,	T Th,	at 9.	Room 310.

2. Elements of Mechanism. *Two or three hours.*

Recitations—

Sec. I,	T Th,	at 9.	Room 409.	Professor Denison.
Sec. II,	T Th,	at 2.	Room 402.	Mr. Wilson.
Sec. III,	T Th,	at 10.	Room 409.	Professor Denison.
Sec. IV,	T Th,	at 11.	Room 409.	Professor Denison.
Sec. V,	T Th,	at 8.	Room 402.	Mr. Wilson.
Sec. VI,	T Th,	at 9.	Room 402.	Mr. Wilson.
Sec. VII,	T Th,	at 11.	Room 427.	Asst. Prof. Goulding.

Drawing—

Sec. I,	M,	from 8-10.	Room 418.	Mr. ———.
Sec. II,	F,	from 8-10.	Room 418.	Mr. Wilson.
Sec. III,	W,	from 10-12.	Room 418.	Mr. ———.
Sec. IV,	W,	from 10-12.	Room 418.	Mr. Wilson.

4. Boilers and Steam Engines. *Two hours.*

Sec. I,	T Th,	at 9.	Room 217.	Professor Allen
Sec. II,	T Th,	at 11.	Room 217.	Asst. Prof. Anderson
Sec. III,	T Th,	at 10.	Room 217.	Professor Allen
Sec. IV,	M W,	at 10.	Room 217.	Professor Allen.
Sec. V,	M W,	at 9.	Room 217.	Asst. Prof. Anderson

6. Machine Design. Machine Tools. *Two hours.*
Sec. I, T Th, from 1-4. Shops. Supt. Miggett.
Sec. II, M F, from 1-4. Shops. Supt. Miggett.

7. Hydraulic Machinery. *Two hours.*
Lectures for all sections, W, at 11. Room 309. Professor Cooley.
Quizzes—
Sec. I, T Th, at 11. Room 219.
Sec. II, T Th, at 10. Room 318.
Sec. III, T Th, at 11. Room 318.
Sec. IV, M F, at 11. Room 318.
Sec. V, M F, at 10. Room 219.

8. Theory of Machine Design. *Three hours.*
Sec. I, M W F, at 9. Room 318. Asst. Prof. Hazelton
Sec. II, M W F, at 10. Room 318. Asst. Prof. Hazelton

10. Machine Design. Hoisting machinery. *Three hours.*
Sec. I, M W F, from 1-4. Room 319. Asst. Prof. Hazelton

11. Laboratory Work. Steam Engineering. *Three hours.*
Sec. I, M F, from 1-6. Asst. Professor Anderson
Sec. II, W (1-6) S (7-12). Asst. Professor Anderson

12. Machine Design. Boilers and Engines. *Two hours.*
Sec. I, T Th, from 8-11. Room 319. Asst. Prof. Hazelton
Sec. II, T Th, from 1-4. Room 319. Asst. Prof. Hazelton

16. Heating and Ventilation. *Two hours.*
M W, at 11. Room 217. Professor Allen.

18. Hydraulic Machinery (advanced). *Two hours.* Hours to be arranged. Professor Cooley.

19. Gas Engines. *Two hours.*
M W, at 8. Room 217. Professor Allen.

20. Laboratory Work. Advanced Course. *Two hours.* Hours to be arranged.

ELECTRICAL ENGINEERING

2. Electrical Measurements. *Four hours.*
Lectures—
Sec. I, M W, at 8. Room 203. Dr. Smith.
Sec. II, T Th, at 8. Room 203. Dr. Smith.
Laboratory—

Sec. I. M F. from 2-5.
Sec. II. T Th. from 2-5.
Sec. III. M F. from 9-12.
Sec. IV. W (2-5) S (8-11).

5. Alternate Current Apparatus. *Four hours.*
Lecture—
M W F. at 8. Room 201. Professor Patterson.
Laboratory—
Sec. I. M. from 1-3. Mr. Bailey.
Sec. II. W. from 1-3. Mr. Bailey.
Sec. III. F. from 1-3. Mr. Bailey.

6. Photometry of Electric Lamps. *One hour.*
Lecture. M. at 9. Room 201. Professor Patterson.
Laboratory sections to be arranged.

7. Design of Electrical Machinery. *Four hours.*
Lectures. T Th. at 8. Room 201. Professor Patterson.
Drawing. T Th. afternoon.

NAVAL ARCHITECTURE AND MARINE ENGINEERING

1. Naval Architecture. Structural Design. *One hour.*
Th. at 10. Room 327. Professor Sadler.

2. Naval Architecture. Ship Calculations. *Two hours.*
T F. at 9. Room 327. Professor Sadler.

3. Naval Architecture. Strength of Ships and Preliminary Design. *Two hours.*
M W. at 9. Room 327. Professor Sadler.

5. Naval Architecture. Mould Loft and Structural Drawing. *Two hours.*
Hours to be arranged in afternoons.

6. Naval Architecture. Ship Drawing and Design. *Three hours.*
M W F, 1-4. Room 323. Professor Sadler and Mr. Bragg.

8. Marine Engines and Boilers. *Two hours.*
M W. at 8. Room 327. Professor Sadler.

10. Marine Engine and Boilers. *One hour.*
Drawing. M. 1-4. Room 327. Professor Sadler.

HISTORY (Elective)

1. The General History of Europe, from the Fourth to the Thirteenth Century. *Four hours.*

Lectures, M W F, at 8. Lecture Room, T. H. Quiz on lectures and reading.

Quiz sections—

Sec. I, M, at 10.
Sec. II, M, at 11.
Sec. III, M, at 2.
Sec. IV, M, at 3.
Sec. V, Tu, at 8.
Sec. VII, Tu, at 10.
Sec. VI, Tu, at 9.
Sec. VIII, Tu, at 11.

Other sections Tuesday afternoon if required. Room 7, T. H. Professor Dow and assistants.

The first of the two courses (see Course 2, second semester) constituting the introductory work in history, deals with such subjects as Europe on the eve of the invasions and the new Germanic states, the development of the church and the papacy, the struggle between the emperors and the popes, the feudal régime, the crusades, and the progress of commerce, industry, and the townspeople.

POLITICAL ECONOMY (Elective)

2. Elements of Political Economy. *Four hours.*

Lectures, M W F, at 3. Lecture Room, T. H.

Quiz sections—

Sec. I, Tu, at 11.
Sec. II, Tu, at 3.
Sec. III, Th, at 2.
Sec. IV, Th, at 3.
Sec. V, F, at 2.

A sixth section is usually formed. All quizzes are held in Room 11 or 4, T. H. Professor Taylor and Dr. Smalley.

This course is introductory to all other courses in political economy. The weekly quiz covers both the lectures and some standard text announced at the beginning of the semester. The ground covered in the lectures includes the usual topics, Production, Exchange, and Distribution; but Public Finance will be reserved for a special course (4).

M612s
1904-05
2d sem

Engineering
4-2-63

UNIVERSITY OF MICHIGAN

DEPARTMENT OF ENGINEERING

SECOND SEMESTER, 1904-5

DIRECTIONS FOR REGISTRATION AND CLASSIFICATION

Entrance. Students entering the Department of Engineering for the first time should present themselves, with their credentials, to the Associate Dean in his office in Room 6 of the *old* Engineering building for admission to the Department. After having been admitted and having paid their fees, they should report at once for assignment to classes in Room 409 on the top floor of the *new* Engineering building. Treasurer's receipt must be presented at this time. Students who desire advanced credit should bring with them at that time their credentials and all drawings made by them if they desire credit in that subject.

Students *re-entering* the department after having withdrawn should present themselves to the Secretary for re-enrollment.

Advanced Credits. Students desiring advanced credits beyond the eight hours which may be given by the Associate Dean for modern language work, should apply to the Associate Dean at the time of admission for a blank upon which the subjects in which credit is desired will be checked. This blank should then be taken to the proper teachers, at the times and places indicated below.

Classification. Each student must appear in person for classification in accordance with the schedule given below. A student who fails to appear at the proper hour will be admitted to classification later upon presenting written excuse for such absence from Associate Dean. This excuse must be obtained in advance of a contemplated absence.

First Year Students:

First year students will appear in Room 409 in the order of their admission numbers, as follows:

Nos. 1676 to 1725, Monday, Feb. 13, at 8 A. M.
Nos. 1726 to 1775, Monday, Feb. 13, at 10 A. M.
Nos. 1776 to 1825; Monday, Feb. 13, at 2 P. M.
Nos. 1826 to 1875, Monday, Feb. 13, at 4 P. M.
Nos. 1876 to 1925, Tuesday, Feb. 14, at 8 A. M.
Nos. 1926 to 1975, Tuesday, Feb. 14, at 10 A. M.
Nos. 1976 to 2025, Tuesday, Feb. 14, at 2 P. M.
Nos. 2026 to 2200, Tuesday, Feb. 14, at 4 P. M.

Second Year Students will appear in Room 309 in the order of their Treasurer's Receipts as follows:

Nos. 1-155, Monday, February 13, at 8 A. M.
Nos. 156-238, Monday, February 13, at 10 A. M.
Nos. 241-343, Monday, February 13, at 2 P. M.
Nos. 344-419, Monday, February 13, at 4 P. M.
Nos. 420-512, Tuesday, February 14, at 8 A. M.
Nos. 512-633, Tuesday, February 14, at 10 A. M.
Nos. 634-804, Tuesday, February 14, at 2P. M.
Nos. 806-969, Tuesday, February 14, at 4 P. M.

Third and Fourth Year Students will be classified in order of appearance as follows:

Civil Engineers. Professor Williams and Asst. Prof. Greene, Room 205.
Mechanical Engineers. Professor Allen, Room 217.
Electrical Engineers. Professor Patterson, Room 201.
Chemical Engineers. Professor Campbell, Chem. Lab.
Marine Engineers. Professor Sadler, Room 327.

Special students in their third or fourth years of residence should report with the regular students of the most closely allied course.

OFFICE HOURS AND ROOMS

For the Week commencing Monday, Feb. 13.

Dean—Professor Cooley. Office hours for students, *11-12*. Room 213.

Associate Dean—Professor Davis. 10:30-11:30, except Saturdays. Room 6.

Secretary—Assistant Professor Goulding. Hours same as Classification Committee. The Secretary's office will be open daily from 8-12 and 1:30-5.

Classification Committee—For rooms see paragraph headed (*Classification.*)

Monday, all classes, 8-12 and 2-6.
Tuesday, all classes, 8-12 and 2-6.

On Tuesday evening classification will be continued at half-past seven, until all students who received numbers before five o'clock have had an opportunity to be classified.

Wednesday }
Thursday } 4-5 P. M.
Friday }
Saturday, 9-10 A. M.

Advanced Credits may be obtained from the following representatives of the several departments. Except when otherwise stated their office hours will be on Monday and Tuesday from 11 till 12.

English	Mr. Abbott. Room 23.
French, German, and Spanish	Assistant Professor Wait. Room 3.
Mathematics	Professor Ziwet. Room 311.
Physics	Professor Carhart, Physical Laboratory.
Chemistry 2	Mr. Smeaton. Room 315.
Chemistry, advanced Metallurgy	Professor Campbell. Chemical Laboratory.
Astronomy	Professor Hall. Room 22, U.
Mineralogy	Assistant Professor Kraus, Tappan Hall.
Geology	Professor Russell. Room 6, top floor, Museum.
Drawing	Professor Denison. Room 414.
Shop Practice	Superintendent Miggett. Engineering Shops.
Surveying	Professor Davis. Room 301. 2-3 P. M. except Saturdays.
Civil Engineering	Professor Williams. Room 205.
Mechanical Engineering	Professor Allen. Room 217.
Electrical Engineering	Professor Patterson. Room 201.
Naval Architecture and Marine Engineering	Professor Sadler. Room 327.

Commencement of Work. The work of the classes in the Engineering Department will begin on Wednesday, February 15, and on and after that date all classes will meet at their regular hours.

SCHEDULE

ABBREVIATIONS: U.—University Hall. T. H.—Tappan Hall. Phys.—Physics Laboratory. Chem.—Chemical Laboratory.

Numbers below 100 not followed by letters indicate the old Engineering building.

Numbers above 100 indicate the new Engineering building.

ENGLISH

1. Paragraph and Theme Writing. *Four hours.*
Sec. I, T W Th S at 8, Room 22. Mr. Abbott.
Sec. II, T W Th S at 8, Room 21. Mr. Tarbox.
Sec. III, M W F S at 10, Room 21. Mr. Tarbox.
Sec. IV, M W F S at 10, Room 22. Mr. Abbott.
Sec. V, T W Th F at 2, Room 21. Mr. Tarbox.
Sec. VI, T W Th F at 2, Room 22. Mr. Fulton.
Sec. VII, M W F S at 9, Room 21. Mr. Abbott.
1*a*. Theme Writing. *Two hours.*
Sec. I, M F at 10, Room 28. Mr. Fulton.
Sec. II, T Th at 11, Room 22. Mr. Fulton.
Sec. III, M F at 3, Room 22. Mr. Fulton.
Sec. IV, T Th at 3, Room 22. Mr. Fulton.
3. Advanced Composition. *Two hours.* (Elective).
This course will be offered if desired by at least six students. Hours to be arranged. Mr. Abbott.

FRENCH

1. Elementary Course. *Four hours.*
Sec. I, M T Th F at 1 ,Room 26. Mr. Adams.
2. Elementary Course continued. *Four hours.*
Sec. I, M T Th F at 8, Room 26. Mr. Bird.
Sec. II, M T Th F at 10, Room 401. Mr. Adams.
Sec III, M T Th F at 2, Room 26. Mr. Bird.
Sec. IV, M T Th F at 3, Room 26. Mr. Adams.
Sec. V, M T Th F at 4, Room 26. Mr. Adams.
3. Reading of French Scientific Literature. *Four hours.*
Not given this semester.
4. Reading of French Scientific Literature continued. *Four hours.*
Sec. I, M T Th F at 8, Room 10. Mr. Adams.
Sec. II, M T Th F at 10, Room 10. Mr. Bird.
Sec. III, M T Th F at 3, Room 10. Mr. Peck.
5. An elective course selected from the following four options. *Three hours.*
a, Advanced Course in French Scientific Literature.

b, French Conversation.
c, Commercial and Journalistic French.
d, Literary French.
This course will be given by Mr. Bird, if elected by six or more students.
Provisionally set for M W F at 4, Room 10.

SPANISH

2. Elementary Course continued. *Four hours.*
Sec. I, M T Th F at 1, Room 28. Mr. Bird.
Sec. II, M T Th F at 1, Room 32. Mr. Peck.

GERMAN

1. Elementary Course. *Four hours.*
Sec. I, M T Th F at 10, Room 1. Mr. Menger.
Sec. II, M T Th F at 1, Room 1. Asst. Prof. Wait.

2. Elementary Course continued, *Four hours.*
Sec. I, M T Th F at 8, Room 1. Mr. Dubee.
Sec. II, M T Th F at 10, Room 32. Mr. Dubee.
Sec. III, M T Th F at 2, Room 1. Mr. Menger.
Sec. IV, M T Th F at 3, Room 1. Mr. Scholl.

3. Reading of German Scientific Literatue. *Four hours.*
Not given this semester.

4. Reading of German Scientific Literature continued. *Four hours.*
Sec. I, M T Th F at 8, Room 32. Mr, Menger.
Sec. II, M T Th F at 10, Room 26. Asst. Professor Wait.
Sec. III, M T Th F at 2, Room 32. Mr. Dubee.
Sec. IV, M T Th F at 2, Room 28. Asst. Professor Wait.
Sec. V, M T Th F at 3, Room 28. Mr. Dubee.
Sec. VI, M T Th F at 4, Room 28. Mr. Menger.
Sec. VII, M T Th F at 4, Room 32. Mr. Scholl
Sec. VIII M T Th F at 3, Room 32. Asst. Professor Wait.

5. An elective course selected from the following four options. *Three hours.*
a, Advanced Course in German Scientific Literature.
b, German Conversation.
c, Commercial and Journalistic German.
d, Literary German.
This course will be given by Asst. Prof. Wait, if elected by six or more students.
Provisionally set for M W F at 9, Room 26.

MATHEMATICS

1. Algebra and Analytical Geometry I. *Four hours.*
Sec. I, T W Th F at 10, Room 6. Dr. Field.

1a. Plane Trigonometry. *Two hours.*

Sec. I,	M W	at 11, Room 327.	Dr. Pierce.

2. Analytical Geometry. *Four hours.*

Sec. I,	T W Th F	at 8, Room 31.	Mr. Butts.
Sec. II,	T W Th F	at 8, Room 24.	Dr. Karpinski.
Sec. III,	T W Th F	at 8, Room 28.	Dr. Field.
Sec. IV,	T W Th F	at 8, Room 27 U.	Dr. Bradshaw.
Sec. V,	T W Th S	at 9, Room 6.	Dr. Running.
Sec. VI,	T W Th S	at 9, Room 28.	Dr. Field.
Sec. VII,	M W F S	at 9, Room 27 U.	Dr. Bradshaw.
Sec. VIII,	M W F S	at 9, Room 24.	Dr. Karpinski.
Sec. IX,	T W Th F	at 10, Room 31.	Mr. Escott.
Sec. X,	T W Th F	at 10, Room 27 U.	Dr. Bradshaw.
Sec. XI,	T W Th F	at 10, Room 24.	Dr Karpinski.
Sec. XIII,	M T Th F	at 11, Room H-U.	Mr. Marshall.
Sec. XIV,	M T Th F	at 11, Room 31.	Mr. Escott.
Sec. XV,	T W Th F	at 11, Room 24.	Dr. Karpinski.

4. Calculus and Mechanics I. *Five hours.*

Sec. I,	M T W Th F	at 8, Room 313.	Prof. Ziwet.
Sec. II,	M T W Th F	at 8, Room H-U.	Professor Markley.
Sec. III,	M T W Th F	at 9, Room 19 U.	Asst. Professor Glover.
Sec. IV,	M T W Th F	at 9, Room 31.	Mr. Butts.
Sec. V,	M T W Th F	at 9, Room 427.	Mr. Marshall.
Sec. VI,	M T W Th F	at 2, Room 31.	Mr. Escott.
Sec. VII,	M T W Th F	at 2, Room 203.	Dr. Pierce.
Sec. VIII,	M T W Th F	at 2, Room 313.	Dr. Running.
Sec. IX,	M T W Th F	at 3, Room 203.	Dr. Pierce.
Sec. X,	M T W Th F	at 3, Room 313.	Dr. Field.

6. Calculus and Mechanics III. *Two hours.*

Sec. I,	T Th	at 8, Room 427.	Mr. Marshall.
Sec. II,	T Th	at 8, Room 19 U. H.	Asst. Professor Glover.
Sec. III,	T Th	at 10, Room 313.	Prof. Ziwet.
Sec. IV,	T Th	at 10, Room 21.	Dr. Running.
Sec. V,	T Th	at 10, Room 203.	Dr. Pierce.
Sec. VI,	T Th	at 11, Room 1 T. H.	Mr. Butts.

Sec. VII, T Th at 11, Room 203. Dr. Pierce.

PHYSICS

1. Mechanics, Sound and Light will not be given the second semester of this year, but will be given in the first semester 1905-6.

3*c*. Laboratory work in Mechanical and Electrical Measurements. *Three hours.* Fee $3.00.

Sec. I	M				F		from 8-11, Lab. A, Phys.	Dr. Randall.
Sec. II	M		W				from 2-5, Lab. A, Phys.	Mr. Henderson.
Sec. III		T		Th			from 8-11, Lab. A, Phys.	Dr. Randall.
Sec. IV		T		Th			from 2-5, Lab. A, Phys.	Mr. Henderson.
Sec. V			W			S	from 8-11, Lab. A, Phys.	Dr. Randall.

In addition, one recitation period a week to be arranged with each section.

10. Mathematical Electricity and Magnetism. *Two hours.* Must be preceded by Course 7. Hours to be arranged. Professor Patterson.

16. Theories of Solutions, Electrolytes, and the Voltaic Cell. Lectures and laboratory work. *Three hours.* (Elective). Hours to be arranged. Course 16 must be preceded by Course 2 in Chemistry and by Course 2 in Electrical Engineering. It is also desirable for the student to have had laboratory work in Chemistry. Fee $1.00. This course will not be given this year, but be given in 1905-6.

CHEMISTRY

2. Principles of Inorganic Chemistry. *Four hours.* Lectures W at 11, and S at 9. Lower Lecture Room, Old Medical Building. Mr. Smeaton and Mr. Houghton. Must be preceded by entrance Chemistry.

Quizzes—

Sec. I	M		Th		at 9,	Room B, Chem.	Mr. Smeaton.
Sec. II	M		Th		at 9,	Room 32.	Mr. Houghton.
Sec. III		T		F	at 9,	Room B, Chem.	Mr. Smeaton.
Sec. IV		T		F	at 9,	Room 32.	Mr. Houghton.
Sec. V	M		Th		at 11,	Room A, Chem.	Mr. Smeaton.
Sec. VI	M		Th		at 11,	Room C, Chem.	Mr. Houghton.

Sec. VII T F at 11, Room A, Chem. Mr. Smeaton.
Sec. VIII T F at 11, Room C, Chem. Mr. Houghton.

3. Qualitative Analysis. *Seven hours.* Professor Johnson and Mr. Willard. Must be preceded by Course 2.

Class Work—
Sec. I, M W F at 8, Room B, Chem. Mr. Willard.
Sec. II, M W F at 9, Room B, Chem. Prof. Johnson.
Hours of laboratory work to be arranged.

5. Quantitative Analysis. Beginning Course. *Five hours.*

Class work—
T Th at 9, Room A, Chem. Prof. Campbell.
Hours of laboratory work to be arranged. Must be preceded by Course 3.

28. Advanced Quantitative Analysis. Laboratory work. *Five hours.* Hours to be arranged. Professor Campbell. Must be preceded by Course 5.

29. Iron and Steel Analysis. Laboratory work. *Five hours.* Hours to be arranged. Professor Campbell.
(Elective). Must be preceded by Course 28.

31. Independent Work in . Mineral Analysis. Laboratory work. *Five hours.* Hours to be arranged. Professor Campbell.
(Elective). Must be preceded by Course 28.

34. Chemical Reading. *One or two hours.* Professor Campbell. Hours to be arranged. Requires special permission.

35. Technical Gas Analysis, including Calorimetry and Photometry. Laboratory work. *Two hours.*
Sec. I, M W from 1-4. Asst. Prof. White.
Sec. II, T Th from 1-4. Asst. Prof. White.
Must be preceded by Course 5.

38. Chemical Technology, Organic. *Five hours.*
M T W Th F at 11, Room B, Chem. Asst. Prof. White.
Must be preceded by Course 33.

39. Chemical Technology. Laboratory Work. *Five hours.* Professor Campbell, Assistant Professor White and Mr. Smeaton.
Must be preceded by Courses 28 and 33.

42. Organic Synthesis. Laboratory work. *Three, four or five hours.* Hours to be arranged. Professor Gomberg.

METALLURGY

2. Descriptive study of influence of heat and mechanical treatment upon metals and alloys. *One hour,* to be arranged. Mr. Smeaton. Must be preceded by Course 1.

3. Micrometallography. Laboratory work. *One hour,* to be arranged. Mr. Smeaton. Must be preceded or accompanied by Course 2.

ASTRONOMY

4. Practical Astronomy. *Three hours.* Recitations until April 1, M W F at 9, Room 22, U. Work at observatory three nights a week after April 1. Professor Hall.
9. Practical Astronomy. Advanced Course. Hours and credit to be arranged. (Elective). Observatory. Professor Hall.
13. Theory of Least Squares. *Two hours.*
M F at 10, Room 22, U. (Elective). Professor Hall.

MINERALOGY

1. Elementary Mineralogy. *Two hours.* Assistant Professor Kraus.
Lectures T Th at 11, Room 6, T. H.
Practice one period of two hours to be arranged. Must be preceded by Chemistry 2.
? General Minerology. ***Five hours.*** Assistant Professor Kraus.
Lectures, M T W Th F at 8, Room 6, T. H.
Practice daily at hours to be arranged. Must be preceded by Chemistry 2 and preceded or accompanied by Chemistry 3.
3. Crystal Measurements. *Three hours.* Assistant Professor Kraus.
Laboratory work. Hours to be arranged. Must be preceded by Course 2 or 5.
4. Advanced work along such lines as may be agreed upon . Hours and credits to be arranged. Assistant Professor Kraus.
Mineralogical Laboratory, Tappan Hall.

GEOLOGY

6. Elements of Geology. Dynamic and Structural Geology. *Three hours.*
M W F at 11, Museum Lecture Room.
Professor Russell.
10. Economic Geology. Lectures on the mode of occurrence, deposition, concentration, etc., of raw materials of use to man, metallic and non-metallic minerals, building stones, etc., as affecting their commercial value. Special attention will be given to the mineral wealth of Michigan. *Two hours.*
T Th at 3, Museum Lecture Room. Dr. Lane.
This course should be preceded by a course in Geology.

DRAWING

1. Geometrical Drawing. *Four hours.*
   Sec. I, M T Th F from 8-10, Room 418. Asst. Professor Goulding.
   Sec. II, M T Th F from 8-10, Room 418. Mr. Murphy.
   Sec. III, M T Th F from 10-12, Room 418. Mr. Bartlett.
   Sec. IV, M T Th F from 10-12, Room 415. Mr. Strœbe.
   Sec. V, M T Th F from 2-4, Room 415. Mr. Wilson.
   Sec. VI, M T Th F from 2-4, Room 418. Mr. Murphy.

4. Free-hand Drawing. *Three hours.*
   Sec. I, M W F from 8-10, Room 403. Mr. Strœbe.
   Sec. II, M W F from 10-12, Room 403. Prof. Denison.
   Sec, III, T Th S from 10-12, Room 402. Mr. Murphy.
   Sec. IV, M W F from 10-12, Room 35, Miss Hunt.
   Sec. V, M W F from 2-4, Room 403. Mr. Bartlett.
   Sec. VI, T and Th 2-4, and S 8-10, Room 402. Mr. Strœbe.

5. Descriptive Geometry. Recitations and Drawing. *Four hours.*
   Sec. I, Recitations M W F at 8, Room 401. Mr. Bartlett.
   Drawing T 8-10, Room 415. Mr. Bartlett.
   Sec. II, Recitations M W F at 9, Room 409. Professor Denison.
   Drawing T 8-10, Room 415. Mr. Bartlett.
   Sec. III, Recitations M W F at 8, Room 428. Mr. Wilson.
   Drawing Th 8-10, Room 415. Mr. Wilson.
   Sec. IV, Recitations M W F at 9, Room 428. Mr. Wilson.
   Drawing Th 8-10, Room 415. Mr. Wilson.
   Course 5 must be preceded by Course 1.

6. Shades, Shadows and Perspective. *Three hours.* (Elective). Professor Denison. Hours to be arranged. Course 6 must be preceded by Course 5.

7. Free-Hand Drawing (advanced). *Three Hours.*

(Elective). M W F from 10-12, Room 35. Miss Hunt.

Architectural and Water-Color Drawing. *Two hours.* (Elective).
Sec. I T Th from 8-10, Room 35. Miss Hunt.
Sec. II, T Th from 10-12, Room 35. Miss Hunt.
Course 8 must be preceded by Courses 1 and 4.

Stereotomy. *Two hours.*
Sec. I, T Th at 10, Room 428. Mr. Wilson.
Sec. II, T Th at 10, Room 409. Prof. Denison.
Sec. III, T Th at 11, Room 409. Prof. Denison.
Course 14 must be preceded by Course 5.

Free-Hand Lettering. *Two hours.* (Elective).
Sec. I, M W from 10-12, Room 415 Assistant Professor Goulding.
Course 16 must be preceded by Course 1.

Spherical Projections. *One hour.* (Elective). Professor Denison. Hours to be arranged.
Course 17 must be preceded by Course 5.

P PRACTICE

Carpentry and Blacksmithing. *Four hours.*
Mr. Purfield and Mr. McDonald.
Sec. I, M F 7:30-12. Quiz on T at 10.
Sec. II, T Th 7:30-12. Quiz on M at 11.
Sec. III, W S 7:30-12. Quiz on Th at 10.
Sec. IV, M F 1-5:30. Quiz on Th at 9.

b. Pattern Making. *Two hours.* Mr. Purfield.
Sec. I, T 7:30-12. Quiz on F at 10.
Sec. II, Th 7:30-12. Quiz on T at 9.
Sec. III, M 1-5:30. Quiz on M at 10.
Sec. IV, W 1-5:30. Quiz on M at 9.
Sec. V, S 7:30-12. Quiz on F at 9.

a. Foundry Work. *Two hours.* Mr. Winslow.
Sec. I, M 1-5:30. Quiz on F at 11.
Sec. II, T 1-5:30. Quiz on T at 9.
Sec. III, W 1-5:30. Quiz on M at 11.

Machine Shop. *Four hours.* Mr. Cobb.
Sec. I, M F 7:30-12. Quiz W at 9.
Sec. II, T Th 7:30-12. Quiz W at 3.
Sec. III, M F 1-5:30. Quiz W at 10.
Sec. IV, T Th 1-5:30. Quiz F at 8.
Sec. V, W S 7:30-12. Quiz Th at 8.

b. Machine Shop. .*Two hours.* Mr. Cobb.
Sec. I, W 1-5.30. Quiz F at 10.

4. Instrument Work. *Two hours.*
Not given Second Semester, 1904-5.

SURVEYING

2. Continuation of Course I. Lectures and text-book. *Five hours.*
Sec. I, M T W Th F at 9, Room 301. Professor Davis and Mr. Merrick.

5. Topography. Transit and Stadia. Plane Table. Camera. Field work and Drawing. *Four hours.* Professor Davis and Mr. Merrick.
Sec. I, Recitation M W Th F at 1, Room 301.
Field work and Drawing. M T W Th F from 2-5, Room 302.

7. Geodesy. Geodetic Methods. Lectures and texts. *Three hours.* (Elective).
Sec. I, M W F at 8, Room 301. Professor Davis.
Course 7 must be preceded by Courses 1 and 2.

CIVIL ENGINEERING

2. Tests of Materials. *One hour.* (Elective).
Course 2 must be preceded or accompanied by Course 5. Hours to be arranged with instructor, Mr. Tilden.

3. Graphical Analysis of Structures. *Two hours.*
Sec. I, M W at 8, Room 427. Mr. Tilden.
Sec. II, M W at 11, Room 203. Asst. Prof. Greene.

4. Graphical Analysis of Structures, Advanced. *Two hours.*
Sec. I, T Th at 8, Room 318. Asst. Prof. Wrentmore.
Sec. II, T Th at 11, Room 318. Asst. Prof. Wrentmore.

5. Strength and Resistance of Materials. *Three hours.*
Course 5 must be preceded by Course 4 in Mathematics.
Sec. I, M W F at 8, Room 205. Prof. Williams.
Sec. II, M W F at 8, Room 203. Asst. Professor Greene.
Sec. III, M W F at 9, Room 205. Prof. Williams.
Sec. IV, M W F at 9, Room 203. Mr. Tilden.
Sec. V, M W F at 10, Room 203. Asst. Professor Greene.
Sec. VI, M W F at 10, Room 205. Mr. Tilden.
Sec. VII, M W F at 11, Room 318. Asst. Professor Wrentmore.

8. Engineering Construction. *Three hours.*
Course 8 must be preceded by Course 6.
M W F at 10, Room 318. Asst. Prof. Wrentmore.

10. Hydraulic and Water Supply Engineering. *Five hours.*
Open only to fourth year and Graduate Students.
Course 10 must be preceded by Course 9. Lectures and text-book.
M T W Th F at 11, Room 205. Professor Williams.

11. Engineering Design. Advanced. *Three hours.*
Course 11 must be preceded by Courses 4, 6 and 7.
M W F at 1 to 4, Room 307. Asst. Prof. Greene.

16. Experimental Hydraulics. A study of existing experiments, to be followed by experimental work in the Hydraulic Laboratory. *Two hours.* To be arranged. Prof. Williams.

MECHANICAL ENGINEERING

1. Elements of Machines. *Two hours.*
Sec. I, T Th at 8 . Room 219. Mr. Loomis.

4. Boilers and Engines. *Two hours.*
Sec. I, M F at 9, Room 219. Mr. ———
Sec. II, M W at 11, Room 219. Mr. Loomis.
Sec. III, T Th at 9, Room 219. Mr. Loomis.
Sec. IV, T Th at 11, Room 219. Mr. Bragg.
Course 4 must be preceded or accompanied by Course 4 in Mathematics.

5. Valve Gears. Graphical Statics of Mechanism. *Two hours.*
Sec. I, W F at 8, Room 318. Asst.. Prof. Wrentmore.
Sec. II, W F at 9, Room 401. Mr. Loomis.
Sec. III, T Th at 10, Room 427. Asst. Prof. Goulding.
Sec. IV, T Th at 11, Room 427. Asst. Prof. Goulding.
Course 5 must be preceded by Course 2.

6. Machine Design. Machine Tools. *Two hours.*
Sec. I, M F from 1-4, Shops. Mr. Hargrave
Sec. II, T F from 1-4, Shops. Supt. Miggett
Sec. III, W (1-4) S (8-11) Shops. Mr. Hargrave.
Course 6 must be preceded by Course 2.

7. Hydraulic Machinery. *Two hours.*
Lecture W at 8, Room 219. Mr. Bragg.
Quiz M F at 8, Room 219. Mr. Bragg.
Course 7 must be preceded by Course 4 in Mathematics.

9. Laboratory Work. Power Measurements. *Two hours.*
Sec. I, M from 1-6. Mr. ———.
Sec. II, T from 1-6. Mr. Bursley.
Sec. III, W from 1-6. Mr. ———.
Sec. IV, Th from 1-6. Mr. Bursley.
Sec. V, F from 1-6. Mr. ———.
Course 9 must be preceded by Course 4.

10. Machine Design. Hoisting Machinery. *Three hours.*
Sec. I, M W F from 1-4, Room 315. Asst. Professor Hazelton.
Course 10 must be preceded by Course 8.

11. Laboratory Work. Steam Engineering. *Three hours.*
Sec. I. M F from 1-6. Mr. Bursley.
Sec. II. T Th from 1-6. Asst. Prof. Anderson.
Sec. III. W (1-6) S (8-12). Mr. Bursley.
Course 11 must be preceded by Course 9.

12. Machine Design. Boilers and Engines. *Two hours.*
Sec. I. T Th from 1-4, Room 315. Mr. Loomis.
Course 12 must be preceded by Course 8.

13. Thermodynamics. Steam and other Heat Engines. *Three hours.*
Sec. I. M W F at 9, Room 217. Prof. Allen.
Sec. II. M W F at 10, Room 219. Asst. Prof. Anderson.
Sec. III. M W F at 11, Room 217. Prof. Allen..
Course 13 must be preceded by Course 4

14. Power Plants. Power Transmission. *Two hours.*
Sec I. T Th from 10-12, Room 309. Professor Cooley.

14*a*. Design of Power Plants. *Three hours.*
Sec. I. M W F from 8-11, Room 315. Asst. Professor Hazelton.
Course 14*a* must be accompanied by Course 14.

17. Compressed Air. Mechanical Refrigeration. *Two hours.*
Sec. I. M W at 10, Room 217. Prof. Allen.
Course 17 must be preceded by Course 13.

22. Thermodynamics (advanced). Steam Turbines. *Two hours.*
Sec. I. T Th at 9, Room 217. Prof. Allen.
Course 22 must be preceded by Course 13.

23. Machine Design (advanced). *Two hours.*
Sec. I. T Th from 1-4, Room 315. Asst. Prof. Hazelton.
Course 23 must be preceded by Courses 10 and 12,

ELECTRICAL ENGINEERING

1. Primary and Storage Batteries. *Two hours.* Fee $1.00.
Lectures and Recitations. Mr. Morehouse.
Sec. I T . at 8, Room 20, Physics Bldg.
Sec. II T at 9, Room 20, Physics Bldg.
Sec. III Th at 9, Room 20, Physics Bldg.
Laboratory Work. Physics Bldg.
Sec. I M from 8-10. Lab. B. Mr. Morehouse.
Sec. II M from 10-12. Lab. B. Mr. Morehouse.
Sec. III T from 2-4. Lab. B. Mr. Morehouse.
Sec. IV W from 10-12. Lab. B. Mr. Morehouse.
E. E. 1 must be preceded by Physics 1, 2 and 3 and Chem. 2.

3. Electrical Measurements. Continuation of Course 2. *Three hours.* Fee $2.00.

Lectures and Recitations. Dr. Smith.
Sec. I M at 8, Lecture Room, Physics Bldg.
Sec. II F at 2, Lecture Room, Physics Bdlg.
Laboratory Work. Physics Bldg.
Sec. I M (2-5) F (3-6). Dr. Smith.
Sec. II T Th from 9-12. Mr. Henderson.
Sec. III T Th from 2-5. Dr. Smith.
Sec. IV W (2-5) S (9-12). Dr. Smith.
Sec. V M F from 9-12. Dr. Smith.
E. E. 3 must be preceded by E. E. 2.

4*a*. Dynamo-Electric Machinery. *Four hours.*

Lectures and Recitations. Fee $2.00. Prof. Patterson.
Sec. I M W at 10, Room 201.
Sec. II T Th at 9, Room 201.
Laboratory Work.
Sec. I T Th from 1-3, Room 101. Mr. Bailey.
Sec. II T Th from 10-12, Room 101. Prof. Patterson.
Sec. III M Th from 3-5, Room 101. Mr. Bailey.
Course 4*a* must be preceded by E. E. 2.

4*b*. Dynamo-Electric Machinery. *Three hours.*

Lectures and Recitations. Fee $1.00. Prof. Patterson.
Sec. I M W at 10, Room 201.
Sec. II T Th at 9, Room 201.
Laboratory Work.
Sec. I T from 3-5, Room 101. Mr. Bailey.
Course 4*b* must be preceded by Physics 3*c* or E. E. 2.

8. Distribution of Electricity. *Three hours.*

Lectures and Recitations. Fee $1.00.
Sec. I M W at 8, Room 201. Prof. Patterson.
Laboratory Work.
Sec. I T from 8-10, Room 102. Mr. Bailey.
Sec. II Th from 8-10, Room 102. Mr. Bailey.
Course 8 must be preceded by Course 4.

10. Advanced Course in Design of Electrical Apparatus. *Two hours.* (Elective). Two periods of three hours each. Hours to be arranged. Mr. Bailey.

Course 10 must be preceded by Course 7.

11. Telephone and Telegraph. *Two hours.* (Elective). Lectures and Recitations. Hours to be arranged. Mr. Morehouse.

Course 11 must be preceded by Course 4.

12. Telephone and Telegraph. Laboratory Work (Elective). *Two hours.* Fee $2.00. Hours to be arranged. Room 111. Mr. Morehouse. Course 12 must be preceded or accompanied by Course 11.

13. Electric Railways. *Two hours.* (Elective).

M W at 9, Rom 201. Prof. Patterson.
Course 13 must be preceded by Course 4.

NAVAL ARCHITECTURE AND MARINE ENGINEERING

1. Naval Architecture. Structural Design. *One hour.*
T at 11, Room 327. Prof. Sadler.

2. Naval Architecture. Ship Calculations. *Two hours.*
T Th at 9, Room 327. Mr Bragg.
Course 2 must be preceded or accompanied by Course 4 in Mathematics.

4. Naval Architecture. Stability and Resistance. *Four hours.*
M T W Th at 10, Room 327. Prof. Sadler.
Course 4 must be preceded by Course 2.

5 Naval Architecture. Mold Loft and Structural Drawing. *Two hours.* Hours to be arranged. Room 321. Prof. Sadler and Mr. Bragg.
Course 5 must be preceded or accompanied by Course 1.

7. Naval Architecture. Ship Drawing and Design. *Three hours.*
M W F from 1-4, Room 321. Prof. Sadler and Mr. Bragg.
Course 7 must be preceded or accompanied by Course 2.

9. Marine Engines and Boilers. *Three hours.*
M W F at 9, Room 327. Prof. Sadler.
Course 9 must be preceded by Course 4 in Mechanical Engineering.

11. Marine Engine and Boiler Design. *One hour.*
T from 1-4, Room 321. Prof. Sadler and Mr. Bragg.
Course 11 must be preceded or accompanied by Course 9.

13. Ship and Engine Specifications. *Two hours.*
Hours to be arranged. Room 327. Prof. Sadler.

14. Pumping and Ventilation. *One hour.*
Hours to be arranged. Room 327. Prof. Sadler.

15. Advanced Reading. *Three hours.*
Hours to be arranged. Room 327. Prof. Sadler.

16. Advanced Drawing. *Five hours.*
Hours to be arranged. Room 317. Prof. Sadler and Mr. Bragg.
Courses 13, 14, 15 and 16 must be preceded or accompanied by Course 4.

LAW

1. Engineering Contracts. *One hour.*
Th at 9, Room 309. Prof. Knowlton.